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DATA CONCERNING RADIATION AND PROTECTIVE GLASSES WITH A NOTE ON RETINOSCOPES

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THE publication in 1914 of a paper by Sir William Crookes proved the starting-point of a change in the attitude of the lay public towards protective glasses. Since that date, popular taste in regard to the proper enjoyment of leisure has developed along lines that call for, or appear to call for, some measure of protection for the eyes. The recreations of all classes and both sexes now include long walks, sun-bathing, winter sports, and Mediterranean cruises. Expeditions to the Sahara, exploration of the Arctic, and long-distance flying may almost be termed fashionable. The extended use of radiation in therapeutics, and, not least, constant and persuasive advertising are other factors which have stimulated an ever-increasing demand. Glass manufacturers, particularly abroad, have not been slow to respond. The industry at the present time has attained to considerable proportions. It provides the prescribing surgeon with an embarrassingly rich selection of types, and circulates an extensive trade literature. The position, however, is far from satisfactory. The available literature, being very largely derived from manufacturers and agents, is anything but disinterested. The claims preferred for a particular glass as a rule bear little relation to

its intrinsic merits. Nearly all the widely advertised glasses are of unknown composition, and the latter is not always uniform. There is no certainty, except in one or two instances, that, after the initial supply is exhausted, a new glass can be repeated, as successive melts, or even different parts of the same melt, may possess very different properties. Few of the glasses are made in the British Isles, so that contact between the actual maker and the lens manufacturer or dispensing optician is not very intimate. In almost every instance there is an entire absence of standardization; nor is there any general agreement as to the best standard to adopt. As the composition of each glass is almost invariably a trade secret, and analysis, both chemical and spectroscopic, is tedious, the prescriber is actually in a position similar to that of a physician who had to depend exclusively on a pharmacopoeia of patent remedies. The aim of the present paper, as its title implies, is to assemble the data relating to radiation on the one hand and to the more important types of protective glass on the other, and to attempt to analyse the factors against which protection is desirable and the means at our disposal for ensuring it.

I.—Radiation

Some acquaintance with modern theories concerning the ultimate constitution of matter is indispensable to the study of radiant energy and its effect on living and other substances. The basis of these conceptions is the Rutherford-Bohr theory of atomic structure, which defines the atom in its simplest form as a central, positively charged nucleus surrounded by a cluster of negative electrons which describe circles or Kepler ellipses with the nucleus as focus. In this atom-model a planetary electron rotates in its orbit without the emission or absorption of energy. When, however, an atom is subjected to a field of radiation from an outside source, the energy, not of the light but of its frequency or wave-length, may drive an electron from its orbit. That electron then passes suddenly into another orbit, either nearer the central nucleus or further from it. When this transition takes place from one orbit to another, energy is radiated or absorbed, according to the direction of the transition, in the form of an energy-quantum of homogeneous, monochromatic light. Absorption and radiation are completely reciprocal processes, of essentially the same nature but proceeding in opposite directions. The frequency is just the same for both and only this frequency can effect the transition. Transition from an orbit of low energy level to one of high means absorption; transition from one of high to low means radiation. In the latter case the surplus energy left over, after that expended on the jump, becomes available and is transmuted into a light quantum.

Electromagnetic Radiation

As a preliminary to the consideration of the more restricted field of solar radiation, the whole range of electromagnetic radiation, so far as at present known, is set forth in the following table, with approximate values for the wave-lengths of the several regions. This assignment is, of course, somewhat arbitrary. The energy represented by electromagnetic waves is termed radiant energy.

	*Wave-length**
Cosmic (ultra-gamma) ray	0·001 Å
Gamma ray from radium	0·01 to 0·1 Å
X-ray	0·1 to 50 Å
Millikan—Osgood region	200 Å
Lyman region	600 Å
Schumann region	1,300 Å
Ultra-violet	1,850 to 3,900 Å
Violet	3,900 to 4,240 Å
Blue	4,240 to 4,920 Å
Green	4,920 to 5,350 Å
Yellow	5,350 to 5,860 Å
Orange	5,860 to 6,470 Å
Red	6,470 to 7,500 Å
Infra-red / Rest-strahlen	7,500 to 3×10^6 Å
Electric waves	3×10^6 to 10^7 Å
Hertzian waves	10^7 to 10^{13} Å

Solar Radiation

The quality of solar radiation is about that of a black-body at a temperature of 6,000° C. or 10,000° F. This may be taken as the effective temperature of the sun, although that of its centre on account of enormously high pressure is estimated at 30 to 60 million degrees. The limits of the solar spectrum received on the earth's surface may be said to lie between 30,000 Å in the infra-red and 2,915 Å to 2,900 Å in the ultra-violet (Miethe and Lehmann; Dobson). Langley (1883) found that the solar spectrum could be followed in the infra-red to 180,000 Å though it became very faint after 50,000 Å. (Fig. 1.)

* Throughout this paper wave-lengths are expressed in Ångström Units (Å). Each Ångström unit is equal to one ten-millionth of a millimetre, *i.e.*, 10^{-8} cms.

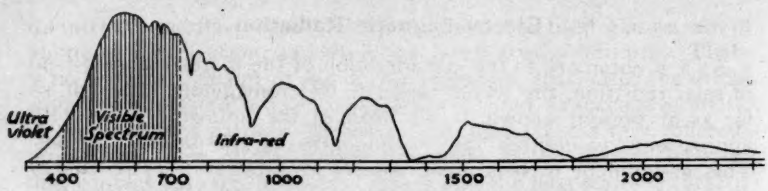

FIG. 1.

Curve showing distribution of energy in the solar spectrum, after Langley.

In estimating the transmission through the atmosphere of direct light from the sun it is commonly said that the noon-day sun passes through a depth of one atmosphere and a low sun through a depth of two atmospheres. As the air is not of uniform density throughout, the ratio of the two masses of air encountered is greater than the ratio of the lengths of the two paths. The ratio of the two

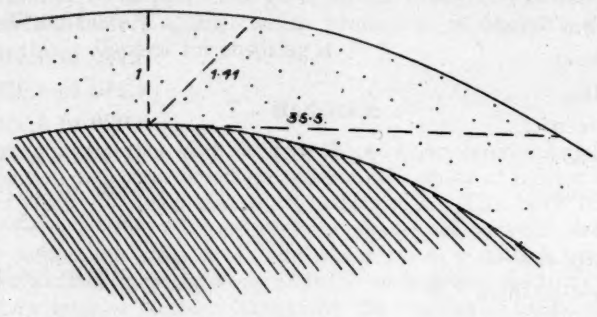

FIG. 2.

Ratio of value of masses of air for the sun in the zenith and on the horizon.

values of the mass of air for the sun in the zenith and on the horizon is 1 : 35·5. (Fig. 2.) The main constituents of the atmosphere responsible for absorption and diffusion of solar radiation are oxygen, ozone, carbon dioxide, water-vapour and dust particles, including smoke. Even a clear atmosphere takes up from 40 per cent. to 50 per cent. of the sunlight—30 per cent. at the zenith and 75 per cent. at the horizon.

Ultra-violet Rays.—From the stratosphere or region of the aurora borealis to the surface of the earth the limiting wave-length of the ultra-violet spectrum recedes from 1,350 Å to 2,900 Å or 2915 Å. The opacity of the atmosphere to short-waved ultra-violet is due, partly, to absorption by oxygen and ozone and, partly, to reflection and scattering. Probably quite three-fourths of the total radiation

received from sun and sky is diffused by reflection from surfaces and large particles and scattered by air molecules, liquid particles and fine dust. Surfaces, *e.g.*. clouds, cause regular reflection and affect all waves; large particles give rise to diffuse reflection and also affect all waves; fine particles cause scattering and affect short waves only. The more minute the particle the more selective the scattering. Scattering of light is inversely proportional in degree to the fourth power of the wave-length (λ^{-4}), hence extreme violet

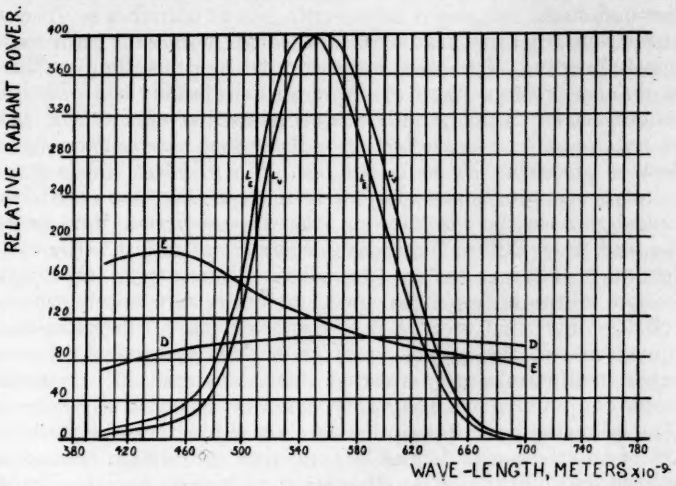

FIG. 3.

Relative spectral distribution of radiant power in D. black-body at 5000° abs. — approximately sunlight. E. Blue sky.

Relative visibility curve for the average human eye. L.V. Source with constant radiant power throughout the visible spectrum. L.E. Blue sky. Gibson and McNicholas.

and ultra-violet rays are diffused 16 times as much as extreme red. This accounts for the blue colour of the sky. When the sun is directly overhead the indirect ultra-violet radiation from the blue sky is 15 per cent. stronger than that direct from the sun. (Fig. 3.)

The total atmospheric content of short-waved radiation is increased by certain atmospheric conditions, *e.g.*, the fine haze of cirrus clouds, which consists of ice needles; by reflection from the earth; and by altitude. Snow and ice, sea and, to a less extent, sand are all good reflectors. As much as 70 per cent. of light may be reflected by snow; even more from snow with a slightly frozen surface. Dry sand and light-coloured rocks can reflect 30 per cent. and grass-land, crops, etc., 15 per cent. Water is almost as good a

reflector as snow for short-wave radiation, so that diffuse light is particularly intense at the sea-side.

Although there is no selective ultra-violet absorption with decrease of altitude, there is a very definite variation in ultra-violet intensity. The zones below 4,000 ft. and the zones above 6,000 ft. are very different. The former do not differ materially from sea-level with regard to intensity of insolation. At 8,000 ft., however, we have left below about a quarter of the mass of the atmosphere, usually about half of the atmospheric vapour, and more than half of the suspended dust.

Insolation intensity is one of the most prominent features of tropical climates. The glare experienced when travelling or flying over deserts or large tracts of dusty, rocky or sandy soil with little or no vegetation is not strictly analogous to that experienced from haze on an antarctic snow-field. Sand and dust have not the regular reflective properties of snow and ice. They reflect diffusely and the relatively gross particles exercise less selective scattering. Tropical glare is the resultant of long-wave radiation from heated rocks and sand, diffuse luminous reflection and diffuse ultra-violet reflection. That is to say, the relative intensity of ultra-violet radiation in the diffuse light spectrum under desert conditions is much less than that of blue sky or snow fields. True ultra-violet conjunctivitis in the tropics, apart from that experienced on snow-covered mountain ranges, is rather infrequent and not very severe. Chronic conjunctivitis of another type, however, is relatively common.

The following brief description of "snow-blindness" is based on notes of an attack experienced by the writer in the high Himalayas, amplified by information kindly placed at his disposal by Dr. G. Murray Levick, who was a member of Captain Scott's last Antarctic Expedition (1910-1913). Strong sunlight with clear skies is a feature of the Antarctic summer. Captain Scott's party at Cape Evans secured a continuous record of 66 hours 25 minutes of sunshine in December, 1911. There was an average of about 14 hours a day in the summer months and the total for the year was considerably more than is experienced in England, although the sun was above the horizon on only 246 days. The risk of conjunctivitis, however, was greater on days of light haze, when the horizon was undefined and sky and snow merged into one. The commonest form of cloud is a very thin stratus consisting of ice particles, which immensely increase the ultra-violet content by scattering. In addition there is reflection from the snow. The risk is less at sea under similar conditions. One attack of conjunctivitis predisposes to others—photo-sensitization. The magnitude of the risk will be appreciated from the fact that during a long day's sledging under appropriate conditions, a slight crack in the sides of the goggles permitted sufficient exposure to precipitate an attack.

Symptoms develop during the evening or at night. At first there is a sensation of grittiness; later agonizing, throbbing pain. Photophobia is acute; the conjunctiva becomes red and swollen, and there is lacrimation and slight discharge. Even in mild attacks the photophobia and throbbing pain are severe. The acute stage lasts for two or three days.

To sum up: at the poles, in the tropics, at sea-level and at altitudes up to 4,000 ft., the range of the ultra-violet spectrum remains constant, extending to a wave-length of about 2,900 Å. The intensity of radiation in the ultra-violet region, on the other hand, is increased through selective dispersion and scattering by ionized particles—indirect blue sky radiation; through non-selective reflection by light clouds and atmospheric haze; and by non-selective reflection from the surface of the earth, particularly from snow and ice-fields, water and desert. The relative absence of suspended dust at altitudes of 6,000 ft. and over permits a high ultra-violet intensity in winter as well as in summer. Tropical sunlight is also characterized by high ultra-violet intensity constant throughout the year.

Infra-Red Rays.—Infra-red radiation includes rays of increasing wave-length and diminishing frequency, ranging from 7,500 Å to several millions. As observed on the earth's surface this region of the solar spectrum extends approximately from 7,500 Å to 30,000 Å. Most of the radiant energy from the sun is in the form of infra-red radiation. Of the total radiation reaching sea-level the infra-red percentage is about 56 per cent. (Kimball).

In its passage through the atmosphere infra-red radiation suffers absorption, mainly by carbon-dioxide and water vapour. The absorbing power of the latter for radiant heat is 72 times greater than that of dry air (Tyndall). This property, however, does not begin to be very serious until a wave-length of 9,000 Å to 9,500 Å is reached. The near infra-red, on the contrary, is characterized by its ability to travel great distances through hazy or misty atmospheres.

The infra-red content of the atmosphere is not well known but it does not always run parallel with the visible daylight intensity. Infra-red rays are relatively immune from scattering.

The total amount of energy which reaches the earth by radiation through space, in the long run is radiated back into space by the earth and atmosphere as long-wave radiation. The amount of energy is the same but the wave-length is longer. All the radiation given out by the earth is in the form of infra-red radiation. The earth as a radiator is similar to a black-body, its effective temperature being equal to about 253° abs. The intensity of the re-radiated energy is much less than that of the absorbed energy, probably about a quarter. Radiating efficiency depends on effective absorption. A perfect absorber is also a perfect radiator. A perfect reflector, on the other hand, can neither transmit, nor absorb, nor radiate. Lack

of vegetation increases absorbing and radiating efficiency, so that the best absorbers of solar radiation are rocks, sand and bare-ground; grasslands and forests are medium absorbers; and water, snow and ice are the worst absorbers. Air is a poor radiator. The wave-length of maximum earth radiation is between 80,000 Å and 120,000 Å, roughly 100,000 Å.

The high radiating efficiency of rocks, sand and bare-ground achieves considerable infra-red intensity in the tropics, and during the day is reinforced by regular reflection. A surface that is sufficiently rough to scatter short waves may give regular reflection of the long heat waves (Lord Rayleigh).

The energy-density distribution of radiant energy at various positions along the optical path in the eye varies according to whether the source is a point object, such as the sun in eclipse, or an extended object, such as a tank of molten glass or metal. The optical path in both examples is shown in Fig. 4. If the intensity and spectral quality of the radiation from a luminous source of large extensity are equal to those from a point source, the amount of energy that passes through the pupil in the first case is much greater than in the second and the retinal image will be equally bright throughout. The relation between the pupillary area and the illuminating source is a logarithmic one. The visual field subtends approximately a solid angle of 120°. The ratio of energy-densities in the plane of the pupil will be approximately equal to the ratio of the solid angles subtended by the sources. Therefore, in the case of an extended object the energy is concentrated in the lens; in the case of a point object on the retina. Theoretically, cataract formation from habitual exposure to infra-red and visible radiation, whether directly from action on the lens protein or indirectly from the effect on iris and ciliary body, is no more improbable than the production of a thermal lesion in the retina through gazing at the sun.

Summary: the near infra-red region from 7,500 Å to 9,000 Å is characterized by the property of haze penetration. From 9,000 Å

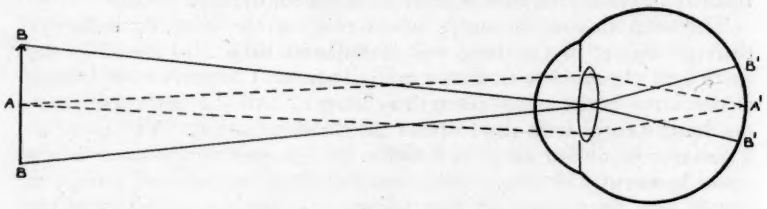

FIG. 4.

Transmission curve of white crown glass. A. 1·68 mm. thick. B. 2·33 mm. thick. Also relative visibility curve of the human eye for an equal energy spectrum. Gibson and McNicholas.

onward strong water-vapour absorption takes place. High infra-red intensity is associated with the decreased humidity of mountain summits and low intensity with areas near the sea even in the tropics. Earth re-radiation combined with a certain amount of regular infra-red reflection reaches a high intensity in dry tropical climates. This is at a maximum where the soil is barren of vegetation but occurs also from grassland, crops and forests. Infra-red intensity is insignificant over snow or ice-fields or surfaces of water.

Visible Rays.—The extent of the visible spectrum is a subjective phenomenon. It varies somewhat for different observers and is shortened for light of very low intensity. It may be said to extend from 8,100 Å to 7,500 Å at the red end to 3,900 Å at the violet. Within this range the distribution of intensity, which coincides with the distribution of visibility for the average eye, is by no means uniform. The greatest value* is in the region of wave-length 5,550 Å, from which it decreases rapidly to low minimum values at either end of the visible spectrum. The variation of visibility of radiation with the wave-length is a considerable one. That between wave-lengths 5,550 Å and 4,000 Å, for example, represents a very large factor, perhaps 40,000 to 60,000. Figs. 3 and 5 show, plotted in the form of a curve, the relative sensibility of the average human eye to light of different wave-lengths for an equal energy spectrum,† *i.e.*, a source emitting equal amounts of energy at all wave-lengths in the visible spectrum. Such a curve, although similar to, is not identical with the visibility curve of the human eye for the spectrum of sunlight, which may be very luminous as a whole but very weak if only a small interval of wave-length, *e.g.*, in the deep blue, be taken. The total transmission factors for sunlight, however, do not in general differ much from those for a source emitting equal amounts of energy at all wave-lengths (Gibson and McNicholas).

The sole difference between infra-red, visible and ultra-violet radiant energy is that of frequency or wave-length. All visible rays, particularly the red, orange and yellow regions possess the property of radiant heat and all visible rays, but particularly green, blue and violet possess an actinic action. Although it must be assumed that the eyes of living organisms on the surface of the earth are adapted to exposure to radiation of all wave-lengths at least not shorter than

* It is an interesting and significant fact that the wave-length of greatest energy in the solar spectrum—stellar spectra are different—*i.e.*, the wave-length with the greatest number of ergs, is also that for which the human eye has the greatest sensitivity. The absorption of visual purple (rhodopsin) in aqueous solution is at a maximum of 5,030 Å and the absorption spectrum of the photo-sensitive substance, presumably rhodopsin, in the retinal rods shows a maximum at 5,100 Å (Hecht).

† Energy curves of a light source can be determined by comparison with a black-body. The energy units can be computed from Wien's displacement equation and the colour-temperature of the source.

2,900 Å, yet there remains the possibility of depression of visual function and discomfort or even injury from excess. Intrinsic brilliancy of a high order may cause absorption of excessive energy by the media of the eye or may produce excessively bright images upon the retina. There is also the problem of glare.

It is difficult to define glare satisfactorily. Certain varieties have been described under such names as veiling glare, contrast glare, dazzling glare, brightness glare, reflection glare, etc. It may be said, however, that the sensation of glare depends on the relative distribution of brightness within the field of vision. A certain, usually limited, part of the field is excessively bright, causing interference with vision, such as a blinding effect or dazzling, or causing annoyance and discomfort, probably as a result of undue strain on the delicate mechanism which regulates the admission of light. It is evident that a light source emitting brightness of a high order of magnitude may over-stimulate the physiological mechanism of vision and upset normal retinal adaptation. An angular position of the source of light relative to the direction of vision, by tending to capture the attention or by directing light into the eye at unaccustomed angles, may cause a sensation of glare even without the factor of high intrinsic brilliancy. Too little contrast in the field of vision may be as bad as too much. With completely diffuse illumination, shadows are lacking; all specular surfaces glitter; and the general effect is unpleasant. The eye functions to the best advantage when contrasts in the field are not less than about 2 per cent. and not more than 10 per cent. The best ratio of diffuse to total light appears to be between 30 per cent. and 60 per cent. Finally, visual depression may be due to haze resulting from scattered light within the eye, as experiments have shown that this is greatest when the light falls upon the optic papilla and is reflected from it (Borschke, 1904; Cobb, 1911). As a general rule, however, glare resolves itself into specular reflection. Further, glare is a property of the visible spectrum, perhaps mainly of the region of wave-length 5,550 Å, which has been shown to be the region of maximum energy. It has nothing to do with either ultra-violet or infra-red rays.

The phenomenon of specular reflection is pertinent to the present discussion. It is characterized by the fact that the incident beam, the reflected beam and the normal to the surface at the point of impact all lie in the same plane. Any surface can be made specularly reflecting to a beam of light if the height of the inequalities of the surface projected on the beam direction is less than one wave-length. Even a dead black surface reflects well at grazing incidence. Thus, a piece of smoked glass, which at perpendicular incidence will not reflect light, *e.g.*, from a lamp, gives a clear reflected image at near grazing incidence. The colour of the image

is at first red but becomes white as the glancing angle, *i.e.*, the angle between the impinging beam and the plane of the surface, is decreased. If θ_0 is the glancing angle, the condition for specular reflection is $h \sin \theta_0 \backsim \lambda$, where h is the average height of the inequalities on the surface. The inequalities on the most perfect possible mechanically polished surface are of the order 10^{-5} cm.

In 1808 Malus discovered that when light is reflected at a particular angle from the surface of water, glass or almost any other except metallic substances, it is nearly completely polarized in the plane of incidence. This particular angle of incidence is called the polarizing angle and at this angle the reflected and refracted rays are at right angles to one another. The degree of polarization of the reflected rays varies with the angle of incidence and is at a maximum at the polarizing angle. This angle is not the same for all substances. It varies with their refractive index according to Brewster's law,* and, in general, the most effective angle of reflection is greater, the greater the refractive index. Not only is the reflected ray partly polarized but the refracted ray also, though in a lesser degree.

Polarized light behaves at reflection in an essentially different manner from ordinary light. As has already been seen the reflected intensity of ordinary light increases with increasing angle of incidence up to grazing incidence. That of polarized light reaches a minimum at the polarizing angle and increases as the angle is increased.

The surface reflection from a sheet of rough water, *e.g.*, a river, illuminated by both sun and sky, prevents the eye from seeing into its depths. If, however, we view the water through a plate of tourmaline cut parallel to the optic axis of the crystal, under certain conditions surface reflection is eliminated, the water becomes transparent; and its contents become visible to the eye. Thus, when the crystal is rotated in its own plane in front of the eye, it will be found that in one position the intensity of the reflection is unaffected. On continuing to rotate the reflected light is observed to fade and, finally, when the plate has been turned through a right angle to become extinguished. This experiment shows the surface reflection from water to be partly polarized. Actually, specularly reflected light is almost completely plane polarized; diffusely reflected light, however, is unpolarized. Blue light from the sky is also polarized. This can readily be verified by using tourmaline or a Nicol prism. Glare, in short, is largely the effect of polarized light and is present whenever the eye is so placed as to receive reflected rays at the polarizing angle. More accurately, glare, as represented by specular reflection, is a resultant of two components: (1) polarized light

*Brewster's law: $\tan. i = n$, where i is the required angle of incidence and n is the index of refraction.

which is present whenever the eye is so placed as to receive reflected rays at the polarizing angle; and (2) ordinary regular reflection combined with a certain amount of diffuse reflection in all other relations of the eye to the reflected light. The intensity of the former, which is by far the more important, can be diminished only by some such instrument as a plate of tourmaline acting as an analyser; the latter perhaps only by selectively absorbing or reflecting the rays in the region of maximum energy; *i.e.*, in the yellow-green round about wave-length 5,550 Å.

II.—Protective Glasses

Glass is the result of fusing silica, generally in the form of sand, with active mineral solvents or fluxes, *e.g.*, the alkalies, such as Na or K; earthy bases such as lime or barium; or metallic oxides, such as oxide of lead. It is not a homogeneous or definite chemical compound. In a physical sense glass is a super-cooled or solid solution of a very high viscosity. It apparently consists of one or more solid phases in fine suspension in a liquid phase or in colloidal solution. The essential element is silica, $Si\,0_2$. The acids are silicic acid, and, in optical glass, boric acid; the alkalies, Na and K, are used in the form of carbonates, sulphates or nitrates; and the other bases as barium or calcium carbonates. Sodium and potassium silicate are soluble in water, consequently, other bases, such as lead oxide, barium or lime, are added to form more insoluble combinations, such as the double silicates of soda and lime. Potassium nitrate during fusion releases oxygen and thus keeps up an oxidising action. The reactions which occur during fusion are complex and imperfectly understood. Possibly there is some formation of chemical compounds, probably of considerable molecular complexity. On the whole the absorption spectrum is that of $Si\,0_2$.

Optical glass does not differ in composition from any other glass. It often contains lead or zinc oxide, especially in association with boric acid. The raw material must be the finest and purest obtainable. The sand must be washed free of salt, chalk and other impurities and heated to redness to destroy organic matter. It must be rendered homogeneous and fit for use in optical instruments by prolonged mechanical agitation of the molten metal. It must be free from striae, irregularities of density, bubbles and other defects, and conform to a fixed standard in respect of refractive index, density, mean dispersion and other optical constants. Probably over 90 per cent. of all the glass manufactured is composed of a combination of silica with a mixture of two bases, soda and lime.

The glass used in spectacles is ordinary white crown glass, *i.e.*, a glass of rather low refractive index, density and mean dispersion. Strictly speaking, spectacle glass is not optical glass because

mechanical agitation is not employed in its manufacture. Such a glass transmits with slight falling off all rays down to 3,500 Å. After this transparency falls off rapidly to zero at about 3,000 Å. Some very light crowns are a little more transparent, but any glass that transmits beyond 3,000 Å at 1 mm. thickness should be rejected. The higher the refractive index the greater the absorption of the shorter wave-lengths, therefore flint glass transmits a narrower

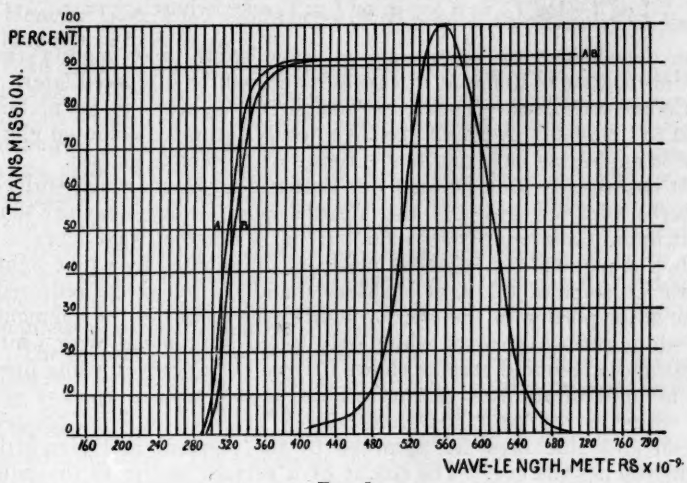

FIG. 5.

Energy-density distribution of radiant energy along the optical path in the eye. (1) From point object A. (2) From extended object B B.

range than crown glass, the limit being about 3,150 Å. Glasses that contain metals of large atomic weight are the most absorbent of the short wave-lengths. The absence of standardization is most unsatisfactory. Spectacle glass should be standardized so as not to transmit through a thickness of 1 mm. rays shorter than at least 3150 Å. White crown glass of this thickness transmits infra-red, though feebly, to about 25,000 Å—30,000 Å (Fig. 5).

The transmission of light through glass, as through other transparent media, accords with Bouguer's law. As the rays pass through successive layers of equal thickness each layer absorbs the same fraction of the energy of the radiation that impinges upon its first surface. That is, if the first millimetre absorbs 1/10th of the incident radiation the next will absorb 1/10th of the remainder and the third 1/10th of what has passed through the second and so on. Hence, the first layer will have transmitted 9/10th; the second $(9/10)^2$; the third $(9/10)^3$; and the n^{th} $(9/10)^n$. The amount

absorbed will be the difference between I_0 and $(9/10)^n I_0$. The amount which survives to pass the n^{th} layer is $I_0 (9/10)^n$.

The relation may be expressed in the form $I = I_0 a^n$ where a represents the fraction of the incident radiation transmitted through unit thickness of the absorbing substance, glass, air, etc., and is therefore defined as the coefficient of transmission. This is a logarithmic or exponential law which may be expressed as

$$\text{Log } I - \log I_0 = n \log a, \text{ or } I = I_0 e^{-kn}, \text{ where } e^{-k} = a.$$

The dependence of absorption on wave-length may modify the colour of glass in different thicknesses and will be discussed later.

Coloured Glasses.—The term "coloured" appears to be preferable to "tinted." A tinted glass is a feebly saturated coloured glass and is applicable only to a few varieties of protective glasses.

It has already been pointed out that a dead-black, rough surface absorbs infra-red rays. It also absorbs nearly every other ray that falls upon it and emits over a similarly large range of wave-lengths.* When a pigment or coloured fabric is illuminated by white light, however, some of the light is absorbed and the remainder reflected. The latter portion of the original light is the colour of the pigment. A white surface appears white only when illuminated with white light and a coloured surface shows its true colour only in white light or in light of its own colour. Thus, a red surface appears red in white or red light but almost black in green or blue, because green and blue rays are absorbed by the pigment and very little light reaches the eye. The colour of a surface is due to the non-absorbed light; the absorbed light is complementary and may initiate chemical change. The colour of a glass, on the other hand, is that of the transmitted light, and, sometimes, partly of scattered light. All glasses have some power of selective absorption, *i.e.*, all glasses are coloured, as can be seen when a sheet of glass that appears to be crystal clear is viewed edgewise. Transmission through glass is therefore always selective. The rays absorbed are roughly complementary in colour to the rays transmitted, *i.e.*, to the colour of the glass.

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* Such a body when heated at first emits only dark rays. Later, at 525° C, it begins to glow visibly, first with a reddish colour, then yellowish, and finally it becomes white hot. The following digression may perhaps be pardoned because of its ophthalmological interest. In 1895 Eugen Dubois published a theory of the origin of colour blindness, regarding it as a reversion to the conditions obtaining in previous geological epochs when radiation of certain wave-lengths was absent from the solar spectrum. Dubois assumed that our sun has passed through a series of stages represented now by various fixed stars At first, there was a stage represented by blue-white stars, when radiation was more intense and the terrestrial climate warm. Next, the sun changed to yellow, radiation diminished and the earth cooled. This was during the Tertiary period and at intervals the sun passed into a third stage, intermediate between yellow and red stars, when radiation was still more feeble—the various glacial epochs of the Quaternary.

The dependence of absorption on wave-length has already been noticed. This may modify the colour of a glass according to its thickness. Thus, cobalt blue glass is moderately transparent for blue light over a broad band and very transparent for a narrow band in the deep red. If the coefficient of transmission is 0·1 for blue and 0·9 for red for a layer of 1 mm., then for 2 mm. the transmitted blue will be 0·01 and the transmitted red 0·81. For a third layer the values will be 0·001 for the blue and 0·729 for the red. Hence a layer a few millimetres in thickness is practically no longer blue but very definitely red.

In coloured glasses the pigment generally used consists of metallic oxides. These are in chemical combination; in true solution; or in fine suspension. Apparently some chemical action occurs. Some colours are obtained by the combination of two or more coloured salts, giving a great variety of shades. The colour produced varies largely with variations in the composition of the glass, and is also influenced by the conditions during melting. The more acid in character the batch, *i.e.*, the greater the proportion of silica, the more readily is oxygen evolved. Reducing furnace gases or reducing agents may destroy the colour. Some agents act in a two-fold manner by oxidising and by colouring.

The presence of metallic salts in a state of true solution is inferred because the absorption spectrum is similar for salts dissolved in fluid and in glass. The intensity of the bands varies by altering the composition of a melt in exactly the same way as by concentrating liquid solutions. The depth of the colour and, to some extent, its quality is dependent upon the concentration of the coloured silicate in the glass or, if this be constant, upon the thickness of the glass. The element may be present as the silicate or as some other compound, *e.g.*, borate, phosphate, etc., which is soluble in the glass.

The colour may also be present in colloidal suspension. Siedentopf and Szigmondy were able by oblique illumination to demonstrate the presence of non-atomic or molecular particles of gold in ruby glass.

Transparent coloured glasses may be classified according to their composition or according to their colour. The latter method is more convenient. Practically any colour of glass can be produced by manufacturers. The following notes are confined to a few selected colours but include practically all varieties of protective value.

Amber glass exists in many shades and can be produced by a variety of ingredients. One example contains black manganese dioxide (1 per cent.) and iron oxide. The manganese oxidises the iron, producing the ferric colour, so that the greenish yellow iron colour is superimposed on the violet or purple of the manganese. If the oxides are present in large amount the result is amber.

Amber may also be produced by carbon and by sulphur in colloidal

solution in the glass. The colour depends on the size and shape of the particles; the finer the division the more intense the colouring. Carbon is used as a reducing agent in the form of charcoal, coke, sawdust, even potatoes to produce other colours. In its finely divided form carbon produces a very stable amber. The sulphur colour is destroyed by oxidising agents and the best results are obtained from carbon combined with sulphates in a high alkali glass. The amber bottle of commerce is a carbon amber. Its dark colour is due to part transmission in the green.

Selenium red is the purest red known. It is a common ingredient in amber glass, because thin sections, such as are used for spectacle

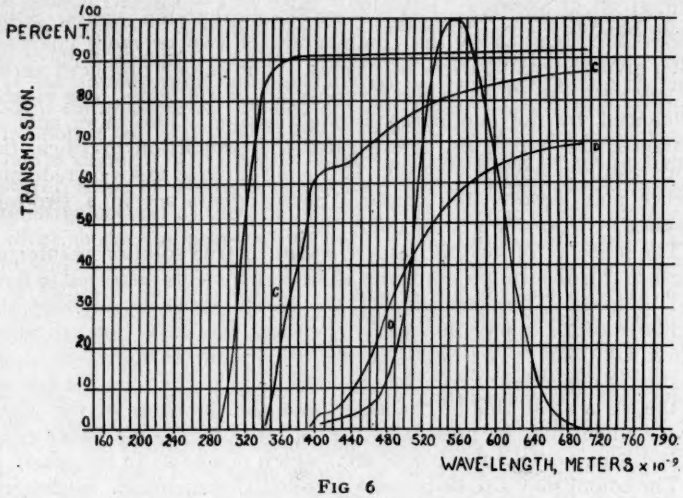

FIG 6

Transmission curves of amber glass. C. Light amber. D. Dark Amber. Gibson and McNicholas.

lenses, transmit some green, resulting in a pink or orange-amber colour.

Amber glass absorbs ultra-violet completely and has high transmission in the visible, up to 85 per cent. It does not affect infra-red. Transmission curves of two specimens of amber, light and dark, are given in Fig. 6. It is also claimed that amber reduces painful glare and gives increased defining power for distant vision under conditions of blue haze, by eliminating the blue and violet rays. Normally, blue rays are out of focus at the retina. Amber causes a certain amount of distortion of colour, but, although it is asserted that interference with the colour sense has a depressing effect, amber, for most people, is rather a cheerful colour.

Yellow and greenish-yellow glasses form a distinct group. The typical yellow glass is canary glass, which has a characteristic yellow colour with a greenish fluorescence due to the presence of uranium. Uranium trioxide, UO_3, is an acid oxide and is generally used in the form of one of its alkali salts, *e.g.*, sodium uranate, $Na_2U_2O_7, 3H_2O$ (0·5 per cent.), which gives excellent colour and fluorescence. Selenium in glass gives a peculiar yellowish rose or pink shade; cadmium sulphide, Cd S, a rich yellow; vanadium confers yellow as well as green tints; and the sulphur compounds of barium produce yellow and deep green. Other yellows, *e.g.*, orange yellow, result from iron, antimony and lead oxide, although antimony is apt to be unstable; greenish yellow from praseodymium; and a clear brilliant yellow from titanium, cerium and vanadium.

Many of the glasses of this group are known under mysterious trade-names, *e.g.*, euphos, akopos (a rather dark shade of euphos); fieuzal; hallauer; saniweld; noviol; and noviweld. The last is a brownish-yellow glass, the brown probably due to nickel sulphate, which protects from ultra-violet and at the same time transmits only 1 per cent. of the infra-red from a furnace at 1,050° C. The green of fieuzal, a dark yellowish-green, is probably due to chromium, and hallauer is a combination of greenish-yellow with a smoke tint. No glass transmits spectral yellow only. Canary glass transmits red, yellow, green, and, in thin sections, one or two bands in the blue. It distorts colour less than medium amber and converts ultra-violet, violet and blue rays, by fluorescence, into yellow-green light. This

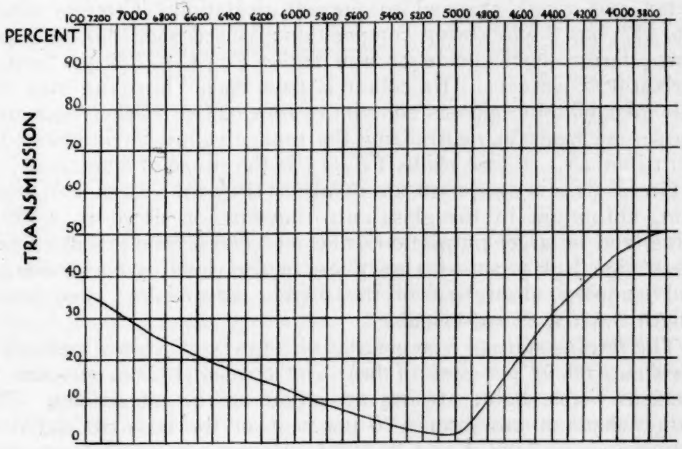

FIG. 7.

Transmission curve of typical yellowish-green glass.

group as a whole may be said to afford efficient protection against ultra-violet (Fig. 7), although the light, yellowish-green euphos, while absorbing at 4,000 Å, begins to re-transmit at 3,200 Å. Generally speaking, glasses of this group obstruct about 60 per cent. of the infra-red radiation from a furnace heated to 1,000° to 1,100° C.

The yellowish-green group of glasses has received an undue amount of attention, especially in America, on account of a statement by Luckiesh that these glasses permit very accurate observations on colour-temperature in industrial processes. The subject of protective glasses for industrial purposes has not been examined in this paper, partly because it is under consideration by the British Scientific Instrument Research Association under its Director, Dr. H. Moore. It is pertinent to state, however, that the views of Luckiesh are not supported by the experience of workers in this country.

Green glasses constitute the next important group. Chromium is one of the oldest and best known green colouring materials. The chromic salts corresponding to basic oxide Cr_2O_3 (2 per cent.) produce a bright grass-green colour; peroxide of copper (0·5 to 3 per cent.) dark bluish-green; and the protoxides of iron (0·5 to 1 per cent.) a somewhat similar colour. Iron is in the ferric state and the colour yellow in the presence of oxidising agents. When the latter are absent in the batch the iron is ferrous and the colour green. Sir William Crookes' famous sage-green glass, No. 246, contains iron in the ferrous state:—raw soda flux 90 parts; ferrous oxalate, $Fe\,C_2O_4$, $2\,H_2O$, 10 parts; with a small quantity of red tartar and wood charcoal to prevent oxidation. Crookes' glass, No. 217, has the following composition:—fused soda flux 96·8 per cent.; ferroso-ferric oxide or iron scales Fe_3O_4 (2·85 per cent.); carbon 0·35 per cent. Its colour is pale blue. Uro and etex are pale greenish-blue glasses containing iron oxide. Other blue iron glasses are made by neutralizing the orange yellow ferric colour by a little cobalt. Ferric oxide, Fe_2O_3 is the rouge of commerce.

Green glass is opaque to ultra-violet. (Fig. 8). Less than 1 per cent. chromium in the glass cuts transmission down to 4,550 A (blue) and in larger proportion as far as 5,600 Å (mid-green). Clear green signal glass shows absorption in the violet, red and orange, and complete absorption in the further ultra-violet; even wavelength 3,650 Å is weakened.

The ferrous state of iron obstructs heat rays. Crookes' sage-green glass cuts off 98 per cent. of heat and transmits 27·6 per cent. of incident visible light. It has no action on the ultra-violet. The darker shade of uro absorbs 70 per cent. of the infra-red radiation between about 7,000 Å and 13,000 Å. Ferric glasses obstruct some ultra-violet; 2 per cent. cuts off ultra-violet to near 4,000 Å. Crookes' No. 217 cuts off all ultra-violet shorter than 3,550 Å;

transmits 40 per cent. of visible light; and only 4 per cent. of heat rays. Ferrous iron is easily the most important agent known for absorbing infra-red radiation. Glasses that absorb highly in the infra-red, however, have either a low transmission throughout the visible spectrum or have the transmission band shifted into the green or blue.

Neutral tints are achieved in a variety of ways. No single colouring agent known confers a neutral colour. The effect can be

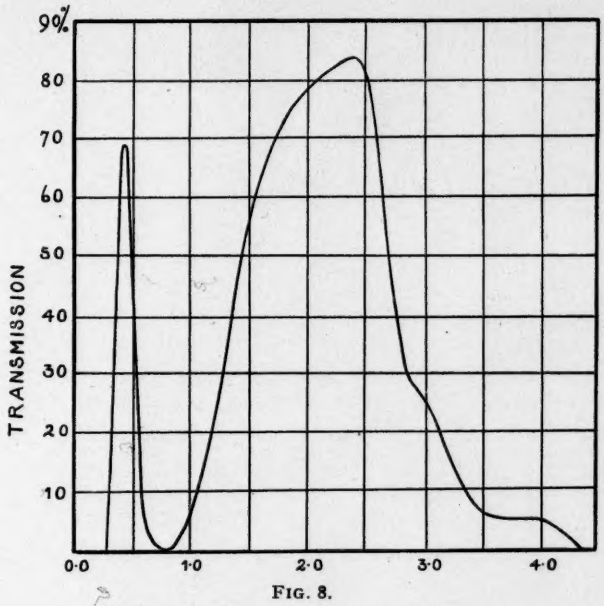

FIG. 8.

Transmission curve of typical green glass.

produced by combining two complementary absorption tints, such as green and purple; brown and blue; yellow and blue; or red and blue-green. In practice, a mixture of colours is used that cuts out almost all tints in the spectrum. Thus, manganese gives a neutral colour to green glass (oxides of copper and iron). Cobalt alone gives a rich blue; nickel alone gives brown; cobalt and nickel combined give neutral grey. Praseodymium gives a greenish-yellow glass; neodymium gives violet; together they produce neutral grey. Cerium, nickel and copper glass is almost neutral. Platinum (0·3 per cent.) with sand, potassium carbonate and red-lead is a translucent grey; the addition of 3 per cent. oxide of iridium makes

it a dense black. Another black glass has a high manganese content, with some cobalt and copper or ferric silicates.

A peculiarity of dark glasses, which is probably physiological rather than physical, is the difficulty of suppressing red. The percentage of transmission of this colour should be cut down considerably relative to the rest of the visible spectrum.

Light amethyst or violet tints are sometimes used as substitutes for neutral grey. The principal agent used is manganese in potash-lime glass. An example is soft-lite. The greatest absorption of light is in the green or blue-green. Manganese has no effect on either ultra-violet or heat radiation. Didymium glass belongs to this group and has the unique merit of cutting out the wave-lengths of greatest radiant energy in the solar spectrum. (Fig. 9). Didymium exhibits a discontinuous emission spectrum. In thick sections two dark bands of medium breadth can be seen through an ordinary hand spectroscope. In thin sections it gives rise to a fine line-like absorption spectrum in the yellow-green. Unfortunately, didymium glass, as a rule, is muddy in appearance and unsuitable for use as a spectacle lens. Chance's didymium glass, however, is perfectly transparent and is probably the best protective glass available for glare in temperate climates. Didymium is a mixture of praseodymium and neodymium and Chance's glass probably owes its

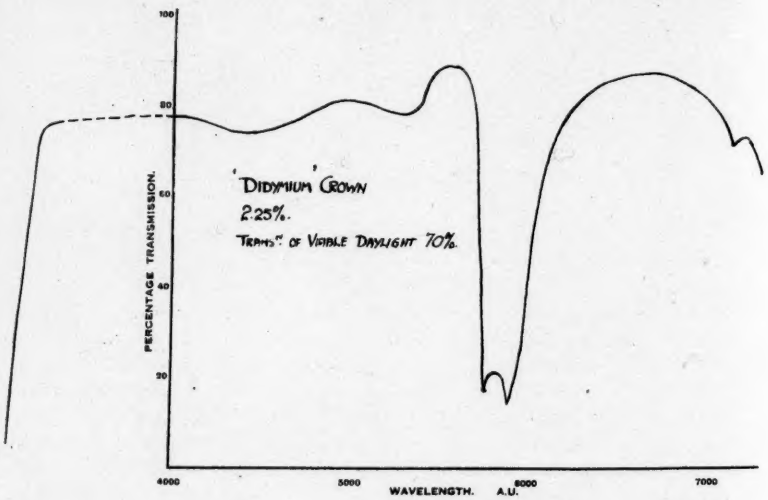

FIG. 9.

Transmission curve of didymium (2·25 per cent.) crown glass. Chance Bros. and Co., Ltd.

superior transparency to the elimination of praseodymium and its freedom from contamination with other rare earth oxides.

Crookes' glass.—The last group comprises the pale, almost colourless glasses, such as the Crookes' A series, which are extremely opaque to ultra-violet. Chance's Crookes' series consists of four types:—A.1, A.2, B.1, B.2. Crookes' A.1 is very nearly colourless, but has a vaseline-like tint when viewed edgewise. A.2 is slightly bluish, due to the presence of cobalt. B.1 is a light neutral shade, darker than A.2; and B.2 is a dark neutral. The last three members

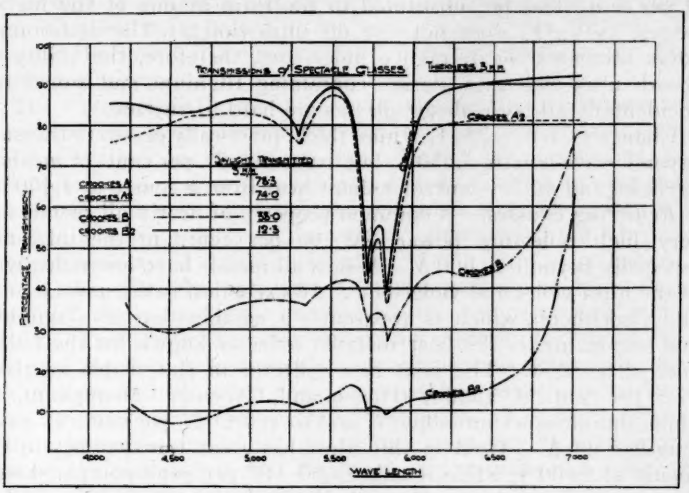

FIG. 10.

Transmission curves of Chance's Crookes' glass A1, A2, B1, B2. Thickness, 3 mm. Chance Bros. and Co., Ltd.

of the series, strictly speaking, belong to the neutral group just discussed. They differ essentially from the members of that group in possessing the specific properties of Crookes' A.1 glass and are more properly described in this section. All Chance's Crookes' glasses contain cerium and didymium. Their spectral transmission curves are shown in Fig. 10, and the glasses are very carefully standardized. The ingredients of Crookes' No. 221 are as follows:—fused soda flux 80 per cent.; cerium nitrate (crystallized) 13·4 per cent.; uranoso-uranic oxide 6·6 per cent. This glass is a faint yellow colour. Its transparency to visible light is 60 per cent.; it cuts off ultra-violet at 3,685 and obstructs 39 per cent. of heat rays. Most rare earth oxides cut off ultra-violet beyond wave-length 3,650 Å and transmit nearly all the visible. The laboratory of the U.S. Bureau of Standards has prepared a soda-lime glass containing

7 per cent cerium oxalate. In thicknesses of 2 mm. this glass has a faint yellowish tinge and transmits 85 per cent. to 88 per cent. of the visible spectrum and only 3 per cent. to 4 per cent. of the 3,650 Å line of the mercury arc. Cerium oxide in a soda flux base is a very pale salmon tint or, in a potash lime flux with 0.2 per cent. manganese dioxide, flesh coloured.

The effect of titanium oxide on ultra-violet absorption is about half that of cerium oxide. A typical glass contains lime, barium, lead or zinc and 6 per cent. titanium dioxide and nitre. Vanadium (1 per cent.) may be substituted in the form of one of the higher oxides, as V_2O_3 does not cut off ultra-violet. The addition of borax increases the refractive index and, therefore, the ability to absorb ultra-violet, of glasses containing titanium and vanadium. Incidentally all boro-silicate glasses are hard to surface.

Chance's Crookes' A. 1, 3 mm. thick, practically ceases to transmit beyond wave-length 3,650 Å, but transmits 77 per cent. of incident daylight, and 40 per cent. of radiant heat from a source at 1,400° C.

Reflecting Glasses.—A common property of nearly all metals is a very high reflecting power (90 - 98 per cent.) in the infra-red, especially beyond 20,000 Å. Almost all metals have low reflectivity in the ultra-violet and violet-blue. An exception is the new German alloy, hochheim, which is apparently a combination of aluminium and silicon, and is the best metallic reflector known for the visible and ultra-violet. The next best reflector in the visible is silver, 92·5 per cent. at 5,550 Å (Hagen and Rubens). Magnalium, an aluminium-magnesium alloy, is said to reflect 67 per cent. at wave-length 2,500 Å. Gold in thin films has great transparency in the region of 5,000 Å, while it reflects 60 – 80 per cent. compared with 4 per cent. from glass. Beyond 20,000 Å the transmission is less than 1 per cent. and ceases entirely beyond 25,000 Å. Gold obstructs 99 per cent. infra-red radiation from a furnace heated to 1,050° C.

About twenty-five years ago Pfund in America patented a gold-plated glass for protection against infra-red radiation in welding and this has been manufactured in that country ever since, and in England for something like ten years. Seven or eight years ago Imre in Hungary re-introduced the gold-plated glass and two additional varieties, platinum and silver. All these glasses are of the type termed "laminated" by the trade, *i.e.*, the metallic film is deposited on the surface of one glass and protected by another superimposed upon it. In the Pfund glass the gold film is usually deposited on Crookes' glass.

Three methods are available for depositing the metal. These are—

(1) Cathode sputtering.
(2) The evaporation process of Ritschl.
(3) The "burning in" process.

Cathode sputtering has numerous industrial applications. When a high voltage discharge takes place *in vacuo* most metallic cathodes slowly disintegrate, and a film of the metal of which the cathode is composed is deposited on objects in its vicinity. The nature of the action is somewhat obscure, but, at least in some cases, it would appear that the particles are torn off from the cathode as a result of positive-ion bombardment.

In the evaporation process, which has been developed mainly by Ritschl of Berlin, a fragment of the metal of which the mirror is to be formed is placed in a high vacuum (10^{-4} mm.) and the object, *e.g.*, the glass to be coated, is set some 10 or 15 cm. distant. On heating the metal it evaporates and part condenses on the glass, forming a mirror.

The "burning in" process is applicable mainly to platinum salts but it has also been successfully used for other rare metals, such as iridium, palladium, vanadium, etc. It has been practised in a rough form and jealously guarded as a trade secret for many years, but during the war was developed to a high state of perfection by Mr. Julius Rheinberg in this country. Essentially, the Rheinberg process consists of coating the glass with a film of collodion in which the platinum salt and a small quantity of bismuth are dissolved, and subjecting it in a furnace to a temperature of 600° or 700° C. This temperature, while stopping short of the point at which the glass tends to become viscous, is sufficient to expand the ultra-microscopic texture of its surface so that the particles of platinum sink into and become incorporated within it. The depth of penetration is somewhere about one or two wave-lengths. In another process the platinum is first deposited on the surface as a film and subsequently burnt in.

Each method has advantages and disadvantages. The "burning in" process has the great merit of not requiring a cover-glass. The metal is actually embedded in the substance of the surface layer of the glass and the latter can be polished and cleansed with impunity. Surfacing and grinding must, of course, be done beforehand. A cover-glass is a great disadvantage in that it absorbs some heat-rays before reflection can occur at the metallic surface and transmits the heat by conduction to the rest of the lens. The "burning in" process, however, has a slight tendency to deform curvature and to render the glass rather brittle. When carried out under factory, as distinct from laboratory conditions, deposition is apt to vary in density and regularity of surface. Cathode sputtering requires a cover-glass to preserve the film. The elements which sputter best are those of high atomic weight. Aluminium, for example, cannot be sputtered. The evaporation process is available for metals of low melting point. Aluminium, tin, silver, gold, can be readily evaporated but platinum cannot. Very fine mirrors are formed in this way, and it is a method applicable to a large number of metals.

The primary use of reflecting glasses is the elimination of infra-red radiation. For this purpose they are extremely suitable, but obstruction of infra-red radiation can be equally well achieved by other methods. For example, Crookes' sage-green ferrous glass absorbs 98 per cent. of heat rays. It has already been stated that a good absorber is also a good radiator and that all absorbers of radiation at a temperature below 500° C. re-radiate the absorbed energy in the form of long-waved infra-red radiation. Thus, any glass that absorbs not only infra-red but also visible and ultra-violet light will in time re-radiate all the energy as infra-red rays in every direction including that of the eye. The supreme merit of reflecting glass is its relative poverty as a radiator and for certain purposes, particularly its use by aviators in hot desert countries, a reflecting glass is unrivalled.

A rough comparison of the efficiency of various types of protective glass for obstructing heat rays can readily be made by means of a radiometer or small light-mill such as is often seen in instrument makers' windows rotating under the influence of sunlight. The movement of the vanes of the radiometer is explained by the action of the air molecules which remain in the glass container. The

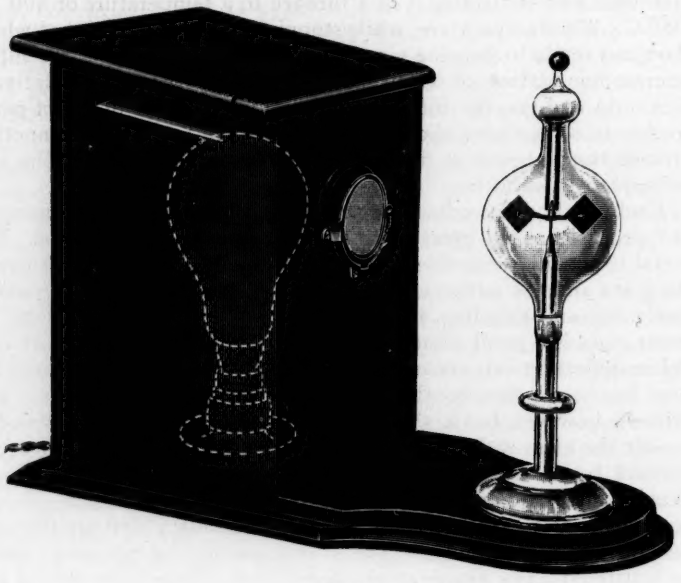

Fig. 11.

Test of heat-obstructing properties of glass by means of a radiometer.

blackened surface gets warmer than the polished one. Any molecule which happens to hit the black surface will rebound with a greater velocity than one which hits the cooler, polished surface. There is, consequently, a greater pressure on the black faces than on the polished one and rotation of the arms is inevitable. A black surface absorbs all the rays of the solar spectrum from the ultra-violet to the far infra-red, the maximum intensity being a little below the Fraunhofer line A in the extreme red. Owing to the predominance of the heat rays, however, the result may be regarded as due to their influence. The source of light, *e.g.*, a 100-watt lamp, is enclosed in a stout wooden box, which is light-proof except for one aperture about the size and shape of a trial-case lens. The radiator stands opposite the aperture and about 3½ inches from it. When the light is switched on, the radiometer (Fig. 11) begins to spin. Various glasses can be placed in succession in front of the opening and their influence on the rate of spinning compared. The following are a few typical results, but the time intervals vary with the temperature of the room:—

1. *Amber:* no effect.
2. *Fieuzal:* no effect.
3. *London smoke:* slows down but does not stop after 35 minutes.
4. *Uro:* slows down but does not stop after 35 minutes.
5. *Gold reflecting glass (flat):* stops in one minute.
6. *Silver reflecting glass (flat):* stops in three minutes.
7. *Platinum reflecting glass (domed):* slows down but does not stop after 35 minutes.
8. *Infrex O:* slows down but does not stop after 35 minutes.
9. *Infrex I:* stops after 30 seconds.

Theoretically, the absorbing glasses, such as infrex *I* ought to restart the radiometer after an interval. When the glass becomes hot and itself acts as a radiator, the secondary radiation is of very long wave-length and to these the glass container of the radiometer is completely opaque.

At my request Mr. L. A. Walters of Messrs. George Spiller, Ltd., to whose interest in this investigation I am much indebted, obtained a report from the National Physical Laboratory, Teddington, on the behaviour with regard to light and heat transmission of Imre's gold glass compared with Crookes' B. The latter was chosen for comparison as it seemed to be the only available glass that was definitely standardized. In each case the glasses were domed, *i.e.*, concave towards the eye, but of zero power.

"The following quantities were measured for one of the glasses of each pair:—

(1) The fraction of visible light transmitted.

(2) The fraction of total heat from a carbon-arc lamp transmitted.

(3) The relative amounts of heat re-radiated from the back surface of each glass when exposed to the same intensity of incident light for the same time.

The results were as follows:—

	Transmitted light.	Transmitted heat.	Relative amount of re-radiated heat.
Crookes' B -	48 per cent.	74 per cent.	1·
Imre - -	36·5 per cent.	28·5 per cent.	1·40

It will be observed that the actual amount of re-radiated heat is greater for the Imre glass than for the Crookes' B. On the other hand, the amount of heat which is not transmitted is 4·47 times as great for the Imre glass as for the Crookes' B. The relative amounts of re-radiated heat per unit of heat not transmitted is only about one-third as much for the Imre glass as for the Crookes' B."

Reflecting glasses have little or no effect on the ultra-violet. Silver transmits ultra-violet freely, having a transmission band at 3160 Å. They also have selective transmission in the visible spectrum. Silver is transparent for blue and violet, and gold for green. Imre claims that platinum holds back the whole visible spectrum evenly and that its colour is a perfect neutral grey. This is not quite accurate, however, as platinum has a definite though slight selective transparency for red.

A Simple Method of Colour Analysis

The only precise method of ascertaining the transmission spectra of glasses is by means of the absorption spectro-photometer. This apparatus, however, is costly, and its use requires special training and experience. The following method was designed by the writer in order to give a rough and rapid estimate of monochromatic transmission through glasses in the visible portion of the spectrum. The results are sufficiently accurate to recommend its use to the dispensing optician. The writer has had the opportunity of examining a large number of coloured glasses of the groups described above and of many not included in these groups. His observations

support the statement that much of the glass manufactured, or at least, sold for protective purposes does not conform to the typical transmission curves selected to illustrate this paper.

The principle of the method is the light sensitivity of a photo-electric cell. The apparatus consists of a source of light, a series of filters, a photo-electric cell and a galvanometer. The best photo-electric cell for the purpose is the Photronic cell. The source of light is an ordinary 20 watt opal electric bulb. Two holders are fixed in series in front of the cell, one to take a filter and the other the glass under examination. To provide a numerical relation between the incident light and the indicator of a measuring instrument, the cell is connected with a resistance adjustment and voltmeter (Fig. 12). Valve amplification is unnecessary. Both the light source and the photo-electric cell are enclosed in a stout box to

Fig. 12.

Circuit diagram of colour analyser. *F*. Filter. *Ga*. Galvanometer. *Gl*. Glass. *P*. Photo-electric cell. *R*. Resistance.

exclude stray daylight. The filters are standard Wratten light filters transmitting only one spectral colour. The complete set consists of seven monochromatic filters, but as few as three will suffice for most purposes, *i.e.*, Nos. 70 (deep red), 72 (orange yellow), and 74 (pure green).

The procedure is as follows: the light is trained on the photo-electric cell and the deflection of the galvanometer indicator noted. After the pointer has come to rest, the first filter is interposed in the path of the beam, causing the pointer to move back a certain distance towards the zero position. The light reaching the photo-electric cell is now monochromatic and the same colour as that of the filter. As the filters have rather narrow transmission bands the amount of light that they absorb is rather high. Usually, however, a sufficiently large margin is left between the zero position and that accounted for by the addition of the filter to enable the necessary calculations to be made. The glass under examination is now inserted in the path of the monochromatic light. If the colour transmitted by the filter is not transmitted by the glass, the pointer moves back to the zero position. If a certain percentage is transmitted, measurement of the deflection will give an approximate value to this percentage. In interpreting the readings obtained,

allowance must be made for the loss of light in transmission through the glass. No serious error will be introduced if this loss is regarded as similar to that of a standard white glass. By interposing in turn the different filters the colours of the spectrum can be examined in succession and the values corresponding to the several filters plotted as a colour curve. The main source of fallacy is infra-red radiation, but the Photronic cell used in this apparatus* is not particularly sensitive to infra-red. Wratten filters do not stand heat and should not be placed too close to the light source.

Applications and Standardization

From the seeming complexity of circumstances in which glasses for protective purposes are really required, three illustrative examples may be chosen, as these three and their variants may be said to cover practically the whole field. The three selected problems are (1) the reduction of glare; (2) the elimination of discomfort for aviators in dry, tropical areas; and (3) protection against ultra-violet conjunctivitis on snowfields. It may be said at once that, with one exception, *viz.*, fluorescent glass, all coloured glasses should now be regarded as obsolete.

The reduction of glare.—Intolerance of glare may be regarded as a form of photophobia which sometimes is physiological and sometimes pathological. In health, considerable tolerance, after a period of adjustment, is normal up to a certain intensity of stimulus, the degree of intensity varying with the individual and with the demands made on his visual activities. The greater the effort exerted by the eyes the lower is the minimum threshold and the more pronounced the disturbance experienced from glare. All departures from health in the eyes, however slight, *e.g.*, minor errors of refraction and muscle balance, mild inflammations of the conjunctiva or lids and *a fortiori*, more serious diseases, tend to decrease tolerance. There is often a nervous element. In some persons intolerance of light amounts to a neurosis which over-protection may accentuate. Unless natural tourmaline lenses can be obtained—and this is practically impossible—or until such time as an artificial analyser of polarized light can be devised, protection against glare in temperate climates at least can be achieved sufficiently well for all practical purposes by wearing lenses of Chance's didymium glass. This glass contains 2·25 per cent. didymium and in sections of 2.25 mm. transmits 70 per cent. of the total visible spectrum. It transmits, however, only 20 per cent. of wave-lengths 5,550 Å up to 6250 Å, *i.e.*, the wave-lengths of maximum radiant energy in the solar spectrum

* The colour analyser described may be obtained from Messrs. Adam Hilger, Ltd., 98, King's Road, N.W.1. I am indebted to Mr. D. R. Follett of that firm for much help in its design.

which are also the wave-lengths for which the human eye possesses maximum sensitivity. A somewhat similar glass is the German neophan. The faint lilac colour of didymium glass in thin sections is inconspicuous in daylight, although occasionally, fastidious blondes have been known to object to the reflection thrown down when rather high-powered convex lenses are worn. The Crookes' A.1 glass also contains didymium and is still less conspicuous but not quite so effective. For more serious cases of intolerance there are available the other members of the Crookes' series, *viz.*: A.2, B.1 and B.2. The rule should be that the lightest tint compatible with comfort should be prescribed. Neutral greys and London smoke tints have no advantage, either of appearance or of cost, over the Crookes' glasses, and, in the writer's opinion, need never be prescribed. The present artificially high cost of Chance's Crookes' glass is the fault, not of the makers, but of opticians.

Aviation in the tropics.—The nature of the radiation to which the aviator is exposed in areas such as the N.W. Frontier of India and Iraq has already been discussed. The chief source of discomfort probably is absorption by and re-radiation from his goggles of long-waved infra-red rays. Whether radiation of this kind is definitely injurious or otherwise is open to question. It may be objected, quite legitimately, that at its worst this radiation is scarcely more harmful to the aviator than that which he would experience if he were sitting quietly on a winter's night in front of a glowing gas-fire. The probable explanation of the discomfort in the former case lies in the associated, sustained, visual concentration and effort to which the eyes of the pilot or observer are subjected and which is rendered tolerable by adequate protection. Theoretically, the ideal glass is Crookes' B.1 or B.2, with a thin metallic film adherent to its outer surface. It has already been explained that most deposition films are unsuitable as they readily become worn off or detached unless protected by a cover-glass. The latter, on the other hand, would itself absorb and conduct the heat which it is desired to reflect. Nor, for other reasons, is it possible to utilise any of the "burning in" methods. There is now being perfected, however, a process which promises to solve all these difficulties. By means of the evaporation method a film of aluminium is deposited on the surface of the lens, providing a very fine mirror of high reflecting power.* It is also very tenacious, resisting scrubbing with paper and other materials most satisfactorily. The resulting glass transmits a pleasant neutral grey which is less depressing than the majority of dark tints and gives a sensation of coolness and shade which should prove of definite psychological valne. The combination, Crookes' B and an aluminium film, is not laminated. At present it is still in the

* The writer is much indebted to Dr. A. Harvey, Assistant Lecturer on Physics, Manchester University, for his valuable and helpful work in perfecting this process.

laboratory stage of development, but there seems no reason why, with continued experience, its production on a commercial scale should not be practicable. If it fulfils its present promise this glass should prove ideal for the aviator in the tropics. It reflects long-waved infra-red such as is derived from terrestrial re-radiation and from regular and diffuse reflection from the ground. Its absorption of these rays is slight, so that the lens does not become hot and act as a re-radiator. Further, it not only provides special protection against infra-red, but, partly by absorption and partly by reflection, against excessive visible and ultra-violet light also.

On snow-fields.—For the conditions that obtain on arctic and antarctic snow-fields a laminated glass is advisable. The suggested basis for this combination is again Crookes' B. 2 glass, upon which a metallic film, ***e.g.***, gold, is sputtered. The cover-glass is a uranium glass, somewhat more amber in colour than ordinary canary glass, and definitely fluorescent. This combination gives adequate protection against excessive visible and infra-red radiation, while the protection afforded against ultra-violet rays is three-fold, ***i.e.***, three different principles are involved in obstructing short-waved, ultra-violet radiation. Firstly, fluorescence, converting ultra-violet into longer-waved rays by means of the uranium cover-glass; secondly, reflection by the gold film; and thirdly, absorption by the Crookes' B element. Further, the psychological factor is not ignored, as the outlook through such a glass is distinctly cheerful. During polar exploration parties or even single individuals are often isolated for long periods in extremely monotonous, fatiguing and depressing conditions. Very dark glasses make the surroundings appear even more gloomy and dreary than they actually are and intensify the tendency to depression. In the glass in question this effect is largely neutralised by considerably reducing transmission of the darker shades, green, blue and violet, relatively to that of the brighter shades, red, orange and yellow.

The uranium cover-glass recommended in the preceding paragraph is the only coloured glass that need be retained for the prescribing of protective lenses, and the manufacture in this country of a standardized form is very desirable. So far as can be ascertained no glass of this description is now being manufactured in the British Isles for optical purposes, although both canary and amber shades made for other purposes are used in so-called sun-spectacles. Such an optical uranium glass must be standardized in two respects:– (1) its transmission curve from the ultra-violet region right through the visible spectrum; (2) its density with regard to visible light. The transmission curve must be constant and should approximate to that of the light amber glass illustrated in Fig. 6, c. Density can be estimated by means of the Hilger-Nutting polarization photometer and expressed as fractions of I, ***i.e.***, $\log_{10} \frac{I_o}{I_t} = D$.

Metallic films, such as gold and aluminium, should likewise conform to a fixed standard of density. Thickness of film can be measured approximately by the time taken for deposition. Possibly it can be ascertained more directly and more accurately by some application of interferometry. Chance's series of glasses, didymium and Crookes', are already satisfactorily standardized.

With regard to frames all that need be said in this place is that metal should not come into contact with the skin in the case of goggles worn in polar latitudes, and that certain materials which act as poor conductors of heat are sometimes surprisingly transparent to infra-red radiation. Thus, the majority of woods, *e.g.*, beech, sycamore, pine, deal, etc., transmit infra-red freely in thicknesses of $\frac{1}{8}$th inch. Celluloid and bakelite of the same thickness are equally transparent. Leather, which is or was used a great deal in the Services, is also transparent in the near infra-red.

A Note on Retinoscopes

Reflecting glasses make excellent retinoscopes. Owing to its high reflectivity in the visible spectrum, silver is better than gold or platinum, though, possibly, liable to become tarnished under the atmospheric conditions of a manufacturing city. A silver retinoscope, however, that has been in constant use in London for about 18 months is still perfectly clear. The absence of an aperture gives a retinoscope of this nature a mechanical advantage, although probably it does not confer any optical advantage, as the amount of light permitted to enter the observer's eye is conditioned by the size of the pupil. A disk rather larger than that of the ordinary plane mirror retinoscope, *i.e.*, about 5 cms. diameter, appears to give the best results. A concave glass, *i.e.*, concave towards the patient, of one dioptre does not appear to have any advantage over a plane glass. Reflecting glass retinoscopes are particularly suitable for minor errors, bordering on emmetropia, and for hypermetropia. They are not so useful for myopia, especially high myopia, nor for eyes in which opacities are present in the lens or cornea. In the writer's experience the old type of concave mirror is the best non-luminous retinoscope for these conditions.

The most difficult eye from the point of view of refraction, and perhaps the one most urgently in need of help, is the eye in which the basic error is masked by a superadded, irregular corneal astigmatism due to corneal nebulae, not necessarily in the pupillary area. Retinoscopy is rendered difficult by irregular reflection from inequalities on the corneal surface. It has been shown above that when the reflected and refracted rays in the plane of incidence are at right angles to one another, the former are plane polarized. In the case of irregular reflection from surface irregularities a large

proportion of the reflected rays may be polarized. If, now, an appropriate plate of transparent tourmaline is placed behind the aperture of a retinoscope and rotated to a position that extinguishes the maximum quantity of polarized rays, the tourmaline acts as an analyser of the polarized light. The scattered rays are largely eliminated and it is sometimes possible to do a satisfactory retinoscopy and discover unsuspected refractive defects. It need hardly

FIG. 13.

Reflecting glass retinoscope. (*a*) Pocket model. (*b*) Consulting room model.

be pointed out that often the result does not materially assist vision, because the best correcting lens does not make corneal haze in the pupillary area any less opaque. In some cases, however, probably owing to the presence of minute points of transparency in this region, a surprising improvement in vision can be obtained. The necessary alteration to a retinoscope is comparatively simple, although good tourmaline is not easy to obtain. Ten years ago Messrs. Hamblin fixed a small plate of tourmaline—part of a lens-tester—on the back of a retinoscope for the writer. A hinge enables the plate to be folded back out of the way when not in use. This device has been used with satisfaction in cases of irregular astigmatism ever since.

The reflecting glass retinoscopes (Fig. 13) are made by Messrs. George Spiller, Ltd., 32, Wigmore Street, W.1, from whom they can be obtained.

REFERENCES

ABBOT, C. G.—*Ann. of Astrophys. Obs.*, Vol. II, p. 128, 1908.
ABNEY, W. DE W.—*Phil. Trans. Roy. Soc.*, Vol. CLXXI, p. 653, 1880.
——— *Ibid.*, Vol. CLXXVII, p. 457, 1886.
ASCHKINASS.—*Ann. d. Phys.*, Vol. LV, p. 401, 1895.
BABCOCK, H. D.—*Phys. Rev.*, Vol. XXIX, p. 748, 1927.
BELL, L.—*Proc. Amer. Acad. Arts and Scs.*, Vol. XLVI, 1912.
BERNER.—*Arch. f. Ophthal.*, Vol. CXIX, p. 363, 1927.
BERRISFORD, P. D.—*Amer. Jl. of Ophthal.*, p. 1,133, 1932.
BERTHOUD, A.—The New Theories of Matter and the Atom. London. 1924.
BIRCH-HIRSCHFELD, A.—*Arch. f. Ophthal.*, Vol. LVIII, p. 469, 1904. *Zeitschr. f. Augenheilk.* Vol. LXXVII, p. 161, 1932. *Deutsch. Med. Wochenschr.*, Vol. LIII, p. 2072, 1927.
BLOCH, O. F.—*Roy. Soc. of Arts*, 1933.
BOHR, N.—The Theory of Spectra and Atomic Constitution. Cambridge. 1922.
——— *Proc. Camb. Phil. Soc.* (Supplement), 1924.
BRACKETT, F. S.—*Astrophys. Jl.*, Vol. LIII, p. 121, 1921.
BUCKINGHAM, J.—Matter and Radiation. Oxford. 1930.
BURGE, W. E.—*Amer. Jl. of Phys.*, Vol. XXXVI, p. 21, 1914; Vol. XXXIX, p. 335, 1916; Vol. XLIII, p. 429, 1917. *Trans. Ill. Eng. Soc.*, Vol. X, p. 932, 1915.
DE CHARDONNET, P.—*Compt. Rend.*, p. 509, 1883.
COBLENTZ, W. W.—*Jl. Frank. Inst.*, Vol. CLXXXVIII, p. 255, 1919.
COBLENTZ, W. W. and EMERSON, W. B.—Technical Papers, U.S. Bureau of Standards. No. 93. Washington. 1919.
CROOKES, SIR W.—*Phil. Trans. Roy. Soc. A.*, Vol. CCXIV, p. 1, 1914.
DARWIN, C. G.—Recent Developments in Atomic Theory. Robert Boyle Lecture. Oxford. 1927.
DEBYE, P.—The Structure of Molecules. London. 1932.
DRUDE, P.—*Lehrbuch der Optik*, 1906.
DUKE-ELDER, W. S.—*Lancet*, Vol. I, pp. 1137, 1188, 1250—1926; Vol. II, p. 16, 1927; *Brit. Jl. of Ophthal.*, Vol. XI, p. 342, 1927; Vol. XIII, p. 1, 1929. Text-Book of Ophthalmology. London. 1932.
ELLIS, CARLTON, and WELLS, A. A.—The Chemical Action of Ultra-violet Rays. New York. 1925.
FOOTE, P. D. and MOHLER, F. L.—The Origin of Spectra. New York. 1922.
GAGE, H. P.—*Trans. Ill. Eng. Soc.*, Vol. XI, p. 1050, 1916.
GARNETT, PHIL.—*Trans. Roy. Soc. A.*, Vol. CCIII, p. 385.
GIBSON, K. S. and MCNICHOLAS, H. J.—Technical Papers, U.S. Bureau of Standards, No. 119. Washington. 1919.
GIBSON, K. S. and TYNDALL, E. P.—*Trans. Ill. Eng. Soc.*, Vol. XIX, p. 176, 1924.
GINELLA.—*Arch. of Ophthal.*, Vol. CXIV, p. 483, 1924.
GLAZEBROOK.—*Dict. Applied Physics.*, Vol. III and IV. London. 1923.
GRAETZ, L.—Recent Developments in Atomic Theory. London. 1923.
GRIFFITH, R. O. and MCKEOWN, A.—Photo-processes in Gaseous and Liquid Systems. London. 1929.
HAAS, A.—Introduction to Theoretical Physics. Vol. II. London. Second edition. 1929.
HAGEN and RUBENS.—*Ann. der Phys.*, Vol. VIII, p. 432, 1902.
HALLAUER.—*Arch. of Ophthal.*, Vol. XXI, p. 1.
HARNED, H. S.—*Jour. Frank. Inst.*, Vol. CXCVI, p. 181, 1923.
HARTRIDGE, H. and HILL, A. V.—*Proc. Roy. Soc. B.*, Vol. LXXXIX, p. 58, 1915.
HECHT.—*Jl. Genl. Phys.*, Vol. III, p. 1, 1920; Vol. III, p. 285, 1921; Vol. VI, p. 731, 1924.
HENRI, V.—Structure des Molécules. Paris. 1925.
HESS, R.—*Arch. fur Augenheilk.*, Vol. LVII, p. 185, 1907.
HESS, V. H.—The Electrical Conductivity of the Atmosphere. London. 1928.
IMRE, J., JR.—*Arch. of Ophthal.*, Vol. LVI, p. 141, 1927.
JEVONS, W.—Band-spectra of Diatomic Molecules. *The Phys. Soc.* London.
KIMBALL, H. H.—*Rev. of Modern Physics*, Vol. IV, pp. 2, 259, 1932.
LANGMUIR.—*Jl. Amer. Med. Chem. Soc.*, Vol. XLII, p. 2190—1920.
LAWSON, SIR A.—*Brit. Jl. of Ophthal.*, Vol. IX. p. 97, 1925.
LIEBEN and KRONFELD.—*Biochem. Zeitschr.*, Vol. XCCVII, p. 136, 1928.

LIVINGSTON, P. C.—*Brit. Jl. of Ophthal.*, Vol. XVI, p. 577, 1932.
LUCKIESH, M.—*Arch. of Ophthal.*, Vol. XLIII, p. 382, 1914.
——— *Amer. Jl. Phys. L.*, p. 383, 1920.
LUCKIESH, M., HALLADAY, L. L. and TAYLOR, A. H.—*Jl. Frank. Inst.*, Vol. XCCVI, p. 353, 1923.
MARTIN, E. K.—*Proc. Roy. Soc. B.*, Vol. LXXXV, p. 319, 1912.
MARTIN, L. C.—*Trans. Opt. Soc.*, Vol. XVIII, 1917.
MIETHE and LEHMANN.—*Sitz. Ber. d. Kgl. Preuss. Akad. d. Wiss.*, Vol. VIII, 1900.
MILLIKAN, R. A.—The Electron. Chicago. 1924.
MULLER.—*Arch. of Ophthal.*, Vol. CXIV, p. 503, 1924.
PLANCK, MAX.—The Origin and Development of the Quantum Theory. Nobel Prize Address. Oxford. 1922.
POWELL, H. J.—Glass making in England. Cambridge. 1923.
RAWLINS, F. I. G. and TAYLOR, A. M.—Infra-red Analysis of Molecular Structure. Cambridge. 1929.
RHEINBERG, J.—*Phys. Soc. Lond.*, 1920.
RUTHERFORD, SIR E.—*Proc. Roy. Soc.*, Vol. XCVII, p. 374, 1920.
SCHANZ, F. and STOCKHAUSEN, K.—*Zeitschr. f. Augenheilk.*, Vol. XXIII, p. 397, 1910.
VERHOEFF, F. H. and BELL, L.—*Tr. Ill. Eng. Soc.*, Vol. XVI, p. 625, 1921.
VOEGE.—*Ill. Eng.*, Vol. II, p. 543, 1909.
VOGT, A.—*Schweiz. med. Wochenschr.*, Vol. LV, p. 425, 1925.
——— *Arch. f. Ophthal.*, Vol. LXXXI, p. 155, 1912.
WOLF, K. L.—*Trans. Faraday Soc.*, p. XXVI, 1930.
ZSIGMONDY, R.—*Zeitschr. f. Instrumen.*, Vol. XXI, p. 97, 1901; *Ann. d. Phys.*, Vol. IV, p. 60, 1901.

A TRANSPARENT PROTRACTOR FOR SCOTOMETERS

BY

JOHN FOSTER

LEEDS

ANY simplication of the means employed to measure the position of any point upon a "Bjerrum-Screen" represents the saving of a considerable amount of time, and wider use of this most sensitive test. The actual test itself demands an unusual amount of concentration from both patient and examiner, and is often very tiring.

Since in addition, the transfer of the map outlined by the pins on the screen to the chart may take almost as long as the original mapping, many ophthalmologists appreciating this difficulty have employed a variety of methods to overcome it.

White lines on the back of the screen are helpful but the points of the pins are less easy to see than the heads, and the positions of scotomata are reversed. Stitched marks on the face of the screen are satisfactory but there is an absence of numbering which makes frequent reference to the centre, and the vertical, or horizontal, meridians desirable; often the radial lines are as far apart as 30°, calling for approximate estimations of considerable magnitude.

The appearance of a projection scotometer capable of making an almost instantaneous record makes the recording time required for the screen even more objectionable, and incidentally suggested a method for decreasing the gap. It occurred to me that a much less elaborate apparatus would suffice to project the chart upon a "Bjerrum-Screen," namely a projection lantern with a miniature scotometer chart as a lantern slide. Unfortunately I had overlooked the fact that a "Bjerrum-Screen" is especially made to reflect as little light as possible, and the effect is not impressive, a very high degree of illumination obviously being required to project white figures on a black background. This method could still be utilised with a white screen and a black object, provided that the illumination were kept low enough to avoid dazzling, and that if comparative results were required, the black test objects were made slightly larger than the white ones used with a "Bjerrum-Screen," to allow for irradiation. It could also be employed by projecting black lines

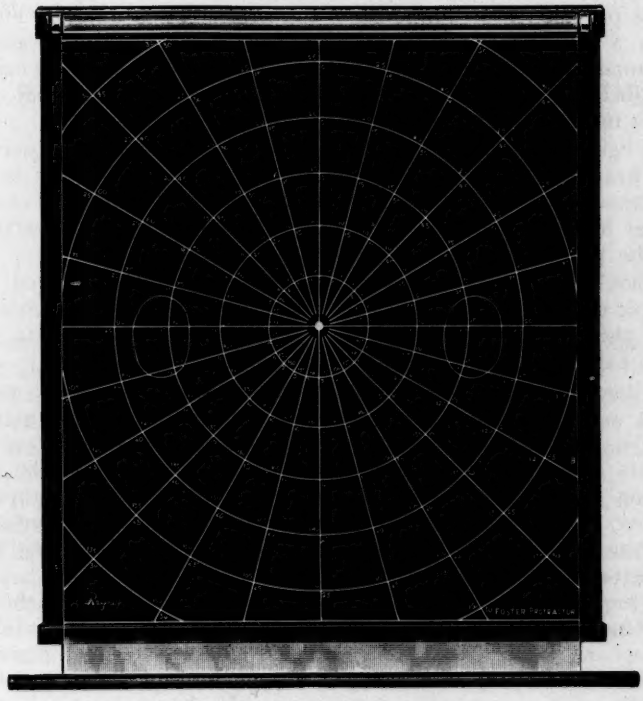

FIG. 1.

Scotometer Board with Protractor.

on to the black background, as (since the original writing of this paper, September, 1932) has been done by another author (Tudor-Thomas).

The next method of projecting the chart on to the screen was by means of a transparent protractor which could be laid over the whole screen, sub-divided as closely as required, and with definite numbering at frequent intervals to indicate the meridian and the angular distance from the fixation point.

The protractor is made of heavy transparent cellophane, about as thick as, and similar in some respects to cartridge paper, marked with radial lines and concentric circles. At the 15° intersections of the radii and circles there are red figures to indicate the angular distance from the centre, and white figures to number the radii in degrees in accordance with the usual McHardy convention.

There is a stick attached to the bottom edge, and when not in use the protractor is rolled up upon it.

After the scotometric map of the central field of vision has been made on the "Bjerrum-Screen" the protractor is unrolled either from a roller-blind mounting above the screen as shown above, or pinned to the screen through four eyelet holes, so that the centre of the protractor is over the fixation point, and the upper and lower margins horizontal.

If lighting is suitable (it is best if above and behind the observer) the heads of the pins can be seen through the protractor and a scotoma of any ordinary complexity and size drawn freehand in under half a minute on a chart which bears the same markings as the protractor.

Should the heads of the pins be not visible, it is a rapid and simple matter to stick in a gold-headed pin beside each black-headed pin, the latter being easily seen through the protractor in any reasonably well-lit room.

Alternative methods of fastening the protractor spring to mind, such as snap fasteners, drawing pins, etc. It can also be marked out in any style desired; with equidistant circles instead of the circles corresponding to the tangents at one metre, thereby rendering it suitable for use at any distance with the appropriate tables; or with radii consisting of dots at unitary distance to correspond with charts already in use; and make mapping even more rapid.

The protractor has so far been made for me with only the 26° field for use at one metre, as the maximum width of commercial sheet cellophane is 39 inches. Mr. McKie Reid, of Liverpool, however, has modified the protractor so that a quadrant of the field, instead of the centre, is marked out on it. If the protractor is then suspended over a central point, and moved and reversed so that it

fits each quadrant of the screen appropriately, it is possible to cover the whole of a two metre screen with it.

An illustration is inset Fig. 1, showing the effect of gold-headed pins marking out a scotoma as seen through the protractor mounted as a wall-roller blind. The instrument as shown is inexpensive, and is easily affixed to a wall or an easel.

I am obliged for assistance in the development of this instrument to Messrs. H. M. Traquair, McKie Reid and John Pike.

The instrument is made by Rayner & Co., 100, New Bond Street.

The instrument can be further improved by a system of even illumination from two "Holophane" reflectors, which can hold 60 watt frosted bulbs on iron brackets. These lamps are mounted on iron brackets and at a position 2 ft. above and in front of the upper corners of the screen with a slight inclination downwards and inwards. This is calculated to give an even illumination of 10 foot-candles over the whole black surface. This intensity of illumination is the same as that now in use on the Bjerrum screen at Moorfields.

EXTENSIVE OCULO-PALPEBRAL NEOPLASM; EXCISION OF LIDS AND ENUCLEATION OF THE EYEBALL, FOLLOWED BY OCCLUSION OF THE ORBIT

BY

PROFESSOR DR. ELENA PUȘCARIU

ROUMANIA

IN our practice it is not unusual to meet with neoplasms of the bulb and lids involving the orbit, whether the tumour had in the beginning an epibulbar, or as more frequently, a palpebral origin.

One would vainly look in the ocular surgical treatises for a method to be followed in such cases, which have been probably considered as incurable, and indicated only for radiotherapy.

For such cases I have long since imagined and practised a method which always gives full satisfaction.

The intervention to be here described, should advantageously be preceded by a preparatory treatment in order to get the surface of the tumour as clean as possible, and to destroy the suppuration germs by means of antiseptic dressings (preferably compresses with Dakin's fluid).

As anaesthetics, if the patient be not too nervous, morphia will be sufficient, associated with retrobulbar injections of novocaine-adrenalin. The same solution is used for the infiltration of the integuments needed for the occlusion of the orbit.

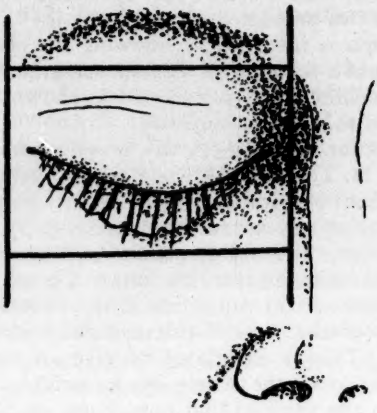

FIG. 1.

The four incisions tangential to the borders of the orbit.

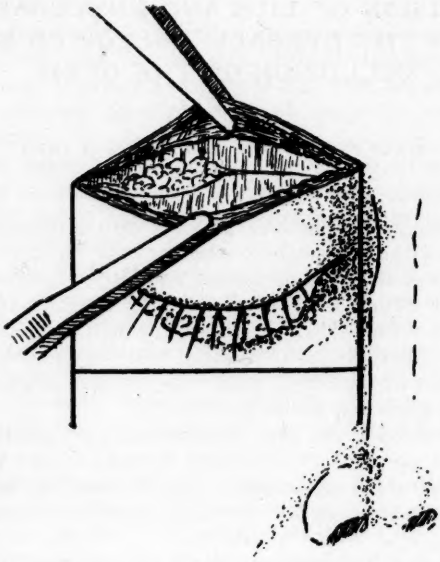

FIG. 2.

The section of the orbital aponeurosis.

The intervention includes the following steps:—

(1) Four linear incisions tangent to the four orbital borders uniting with one another at right angles. The incisions involve the skin and subjacent muscles.

(2) Recognition of the limits of the supra-orbital insertion of the orbital aponeurosis, and incision of it. This opens up the cellular

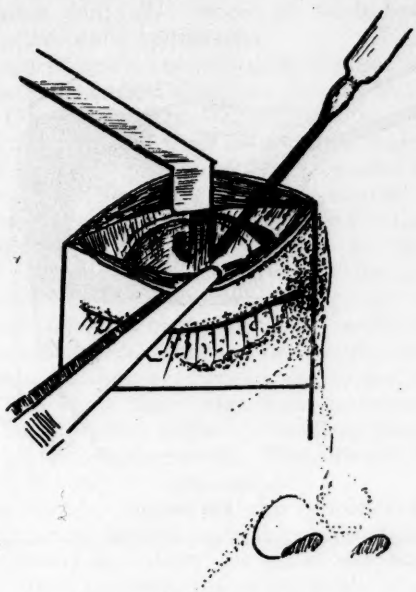

FIG. 3.

Section of the muscles.

orbital tissue and reveals the girth of the rectus superior which is divided after being lifted up on the strabismus hook (Figs. 2 and 3). We repeat the same procedure for the other three incisions, separating the aponeurosis from its orbital insertions, cutting the other three muscles and sectioning also the capsule of Tenon, which extends between them.

We usually proceed after the incision of the superior rectus to that of the rectus externus, then to the rectus inferior, and when we reach the internal section we first detach the insertion of the orbicular tendon which is seized with a haemostatic forceps. This will permit us to proceed after the section of the rectus internus to the third step of our intervention, which is the luxation of the eyeball and the section of the optic nerve, and that of the last muscles and

adhesions (Fig. 4). The piece taken out as a whole appears as in Fig. 5.

In order to perfect the operation we must now cover again the borders of the orbit and the healthy tissues which fill it. For this, we cut two cutaneous flaps, one frontal, the other facial, extending the vertical incisions to the necessary lengths. The flaps, well dissected, are advanced one towards the other in face of the orbit, and are sutured about its centre. We then suture the vertical

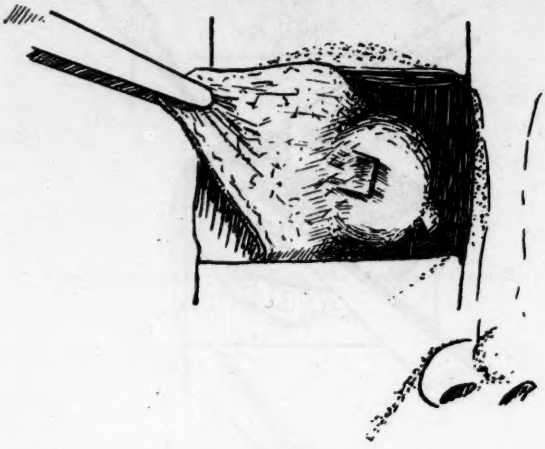

FIG. 4.

The luxation of the eyeball to the outside, and the section of the optic nerve.

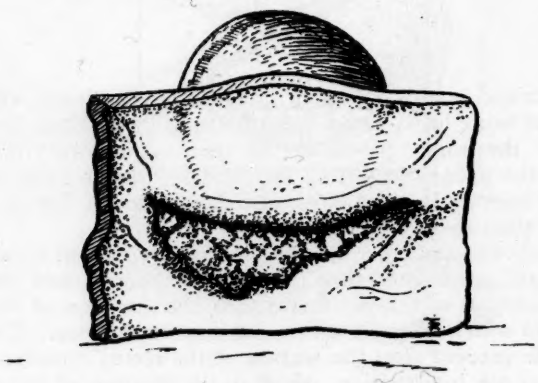

FIG. 5.

Lids and eyeball excised as a whole.

incisions. Finally the result is the presence of the three incisions sutured before the orbit in the shape of an H.

There are, however, cases (as in the description we give below) where the last step is complicated by the great extension of the tumour which requires a very large and irregular incision, and flaps as previously described would be insufficient. My observation and the included photographs, will show the manner in which we have acted in such cases.

Case I. Palpebro-ocular epithelioma.

C. P., male, aged 66 years, a countryman, admitted as an in-patient of the Jassy Ophthalmological clinics on January 26, 1933.

He gave the following history: Denied syphilis, does not smoke. Thirty years ago, he suffered from redness and subjective troubles in each eye. Two years ago, a small ulcer appeared on the edge of his right lower lid. This has gradually extended to the whole edge and has invaded a portion of the lid itself. Last summer it reached the inner canthus and mounted to the upper lid. Later on, the ulceration advanced towards the outer canthus. Before Christmas, the eyeball became congested and the sight rapidly failed completely. For the past three weeks he has suffered with severe headaches, hemicrania and intra-ocular pains.

On examination, his right eye appears watery and shows marked photophobia. The whole ciliary edge, from the internal canthus to the external, is replaced by a vegetant mamillary tissue, with great, shiny, smooth, pinkish embossments. The anterior edge, irregular and festooned shows only 3-4 eyelashes.

On separating the lids, one sees that this neoplastic tissue involves the whole palpebral conjunctiva up to the conjunctival fornices. It occupies both corners and about 1/2 cm. of the extremity of the upper lid. On these portions, the ciliary edge is also destroyed and replaced by vegetant tissue. This tissue is hard and is not adherent to the subjacent regions. The destruction of the palpebral edge uncovers the bulbar conjunctiva in its inferior part, where it appears very congestive and oedematous, at about 5 mm. from the corneal limbus.

The cornea is ulcerated, yellowish, and stains with fluorescein over its whole surface. The blood vessels surpass the supposed limit of the sclero-corneal limbus.

The patient looked asthenic, rather emaciated, with dry skin. Nothing abnormal was found in the lungs, heart or abdominal organs. The preauricular gland was enlarged. The sero-reactions of Bordet-Wassermann and Meinike were negative. Arterial tension 12/9.

The smear made from the ulcer showed very many polymorphonuclear cells and a few gram-positive cocci.

The patient was treated with Hg oxycyanide washings and dressings. He was operated on February 8, 1933. Anaesthesia

with morphia and retrobulbar injections of novocaine-adrenalin. Extirpation of both lids, enucleation of the eyeball, occlusion of the orbit according to the described technique by advancement of two cutaneous flaps.

Subsequent progress. The local post-operative course was perfectly normal. The patient, however, two days later developed a mild attack of influenza with fever. On February 15 the stitches were removed, the flaps were perfectly healed. The patient left the clinics on February 27.

Case II. Oculo-palpebral epithelioma.

S., male, aged 72 years, a countryman, was admitted as an in-patient to the Ophthalmological clinics on April 21, 1932. He gave the following history:—

Three years ago he began to be troubled with itching and scalding of the left upper lid. These symptoms disappeared during the winter, and recurred next summer, being accompanied this time with pain. For a year, a small tumour has appeared, situated in the middle of the lid under the eyebrow. The tumour soon became ulcerated and bleeding. This ulceration has invaded the whole upper lid and has extended to the lower one, being most accentuated at the internal canthus. The eyeball became congested and the sight very much diminished.

On examination both lids of his left eye and the lateral part of the root of the nose appear destroyed, occupied by a vegetant ulceration with irregular margins, reaching the eyebrow, which is also destroyed. The ciliary edges have disappeared through the action of this vegetant tissue. One can distinguish only the external third of the inferior lid. The tumour is covered with dirty brown crusts under which the surface bleeds. The tumour is hard, but movable except for the internal portion.

On separating the vegetant masses and uncovering the eyeball, the cornea appeared cloudy, ulcerated and surrounded by a vegetant red conjunctiva. This appearance became accentuated towards the conjunctival fornices. The palpebral portions of the conjunctiva were also invaded by the neoplastic tissue. The patient appeared weak and anaemic.

The operation was performed on May 5. Morphia 0·03, and local intradermal anaesthetics.

The lids and all integuments invaded by the cancer were excised, and the eyeball enucleated. The orbit was occluded with a fronto-malar flap, which is advanced and torsioned, and with a free graft from the great frontal flap.

The conjunctiva was totally invaded by the neoplastic tissue and the tumour well adherent to the internal part of the orbita. The bone seems covered, however, with apparently normal periosteum. The intra-orbital tissue is not invaded.

FIG. 6.

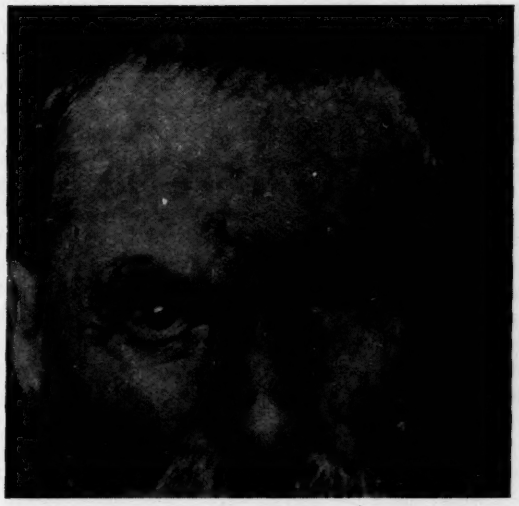

FIG. 7.

May 13, 1932. Second intervention under local anaesthesia (adrenalin-novocaine). The fold from the bridge of the nose was excised.

May 31, 1932, flaps and graft are totally healed.

June 8, 1932. The patient left the clinics. His general appearance seems much improved.

Microscopic examination: Basocellular epithelioma.

Mr. J. B. LAWFORD

THE death of Mr. Lawford on January 3 not only deprives British Ophthalmology of one of its acknowledged heads but is an especially heavy blow to this Journal.

The wings of Azrael have indeed overshadowed the ophthalmic fraternity during the past twelve months: Treacher Collins, Priestley Smith, Herbert Fisher, Maddox and now Lawford.

A memoir, by one who knew him well, will appear in our next number; here we wish to emphasize the loss which the Journal has sustained.

Lawford was elected Chairman of the Editorial Committee on our foundation at the end of the year 1916. But when Mr. Jessop died in February, 1917, the Journal was barely six weeks old. It was a critical time. Lawford became Senior Managing Director of the Company which owns the Journal and with Leslie Paton did a great deal of work to establish it on a sound financial basis and achieved a complete success. At the Annual Meeting, 1926, Lawford resigned his post.

He was an active member of the Editorial Committee from the start until his health broke down about a year ago, and though no longer able to attend our meetings, he continued to work for us until the end. He had had much experience of ophthalmic journals, for he edited the Ophthalmic Review for some years before the British Journal of Ophthalmology was established.

Lawford's name was known all over the Empire. His sterling qualities, his uprightness of character and his logical mind made him an ideally wise and kindly adviser in cases of difficulty, and he certainly never spared time or trouble in the interests either of his friends, or of this Journal.

His public work—whether in connexion with the Ophthalmological Society of the United Kingdom, of which he had been President and Treasurer; with the Council of British Ophthalmologists, of which he had been Chairman; or with the Committee on the Causes and Prevention of Blindness, as well as his hospital work, was carried out with meticulous conscientiousness.

It is with a very special sense of loss that we, of the Editorial Committee, say *Ave atque Vale.*

ABSTRACTS

I.—RETINA

(1) **Sallmann, L. and Sveinsson, K. (Vienna).—On the vision and fields after successful operation in detachment of the retina. (Ueber Sehschärfe und Gesichtsfeld bei operativ geheilter Netzhautabhebung).** *Arch. f. Ophthal.*, Vol. CXXX, p. 1.

(1) **Sallmann** and **Sveinsson** here make an instructive contribution to the study of the visual acuity and fields in retinal detachment after operation. They collected 101 cases from Lindner's clinic successfully treated (*i.e.*, with complete re-attachment of the retina) by the methods of Gonin, Guist and Lindner, and analysed them according to the duration of the disease and, as a basis of subdivision, the vision immediately preceding operation.

As regards the central vision after successful operation the authors show that while improvement depends chiefly on the duration of the disease, operation should be given a trial even in detachments of 1 to 1½ years' standing, because in a large percentage of these cases useful vision can be obtained. Apart from the factor of duration, the prognosis for the vision is, as a rule, more favourable if, prior to operation, it has not sunk below the counting of fingers.

The size and character of the detachment, as well as the age of the patient, have no appreciable influence on the vision of these successful cases; nor has the position of the tears (or the site of the operation), apart from tears at the macula.

The number of operations necessary to effect a cure can have an unfavourable influence on the vision, if the operation has to be repeated more than three times.

In cases of tears at the macula the prognosis after operations with caustic potash is not so unfavourable as might be at first supposed.

None of the operative procedures here considered carries with it any risk as regards the non-improvement of central vision after operation. The cases treated with caustic cauterisation did not show any changes at the macula that could be regarded as a remote effect of the action of the caustic substance. After ignipuncture a remote reaction could not be definitely excluded in individual cases. Certain changes at the macula are associated with the use of caustic, but they are of no practical importance as they do no damage to the vision. Other macular changes are perhaps due to mechanical injury at the operation.

Dense vitreous opacities, causing low central vision, are most frequent after ignipuncture, and occur most seldom after the undermining operation.

The vision obtained shortly after operation may further improve appreciably as time goes on through gradual recovery of the retina.

Investigations on the visual field show that after re-attachment of the retina it increases usually considerably and continues to do so, more rapidly and more fully in recent cases than in those of long standing.

As to colour vision the perception for red returns first, followed by that for blue earlier in recent cases than in old. In detachments of less than one year's standing the field for blue usually increases considerably, so that the physiological arrangement of the colour fields is ultimately attained. In old detachments the limit for blue remains smaller than that for red; in them blue is at first called green.

The later improvement in the field may continue for years.

In contrast to the duration of the disease, the age of the patient and the character of the detachment appear to have no influence on the recovery of the field, nor can too much importance be attached to the extent of the detachment.

While none of the operations offers any special advantage for improvement in the central vision, ignipuncture is less favourable as regards increase of the fields than the other methods, as with it considerable defects in the fields occur most frequently. Numerous repetitions of the trephine method cause an amount of damage that is not explained by the extent of the operation. An appreciable increase in the field with return of the colour sense may be obtained by the use of Lindner's *Lochbrille* after re-attachment of the retina.

The cases treated by the diathermy method were not included with the others, because the number was too small and the period under observation too short; as regards visual acuity and field, however, the results from this operation were not materially different from those obtained by other methods.

THOS. SNOWBALL.

(2) **Kleiner, Leo (Vienna).—The intra-ocular tension in detachment of the retina. (Der intraoculare Druck bei Netzhautablösung).** *Arch. f. Ophthal.*, Vol. CXXIX, p. 485.

(2) The study of the tension in retinal detachment has been pursued for many years, at first by palpation with the fingers and later by means of the tonometer, with varying results. Interest in this question has been revived in recent years through the success that has followed the operative treatment of this condition.

Kleiner has in this paper analysed the tonometric readings he obtained from a large number of cases in Lindner's clinic, and arranged them in tables to illustrate different points.

The results of his investigations are:—

1. The difference in tension between the affected and the normal eye, without distinction between fresh and late cases, amounted on the average to 4 mm. Hg.

2. In nearly three-fourths of all the cases, whether recent or old, the tension in the eye with detachment is lower than that in the other. (It is interesting to note that in a few cases, the author, like other observers, found the tension in the affected eye slightly higher than in the unaffected.)

3. Fifty per cent. of all the affected eyes are hypotonic (*i.e.*, gave readings of less than 16 mm. Hg).

4. The fall in tension is approximately proportional to the age of the detachment.

5. A rise in tension was found in 66 per cent. of the cured cases, tested within four weeks after the operation.

6. The degree of myopia has no practical influence on the tension of an eye with detached retina.

7. The more extensive the detachment (or the larger or more numerous the tears in the retina), the greater the difference in tension between the affected and the normal eye, and the more frequently hypotony occurs.

8. After a period of at least four months after cure of the detachment the tension is usually the same in the two eyes.

The readings obtained in this series of cases, in the author's opinion, furnish further proof of the views put forward by Leber as to the absorption of the fluid in the vitreous by the capillaries of the choroid and by Lindner on the mechanism of detachment of the retina.

THOS. SNOWBALL.

(3) **Arruga, H. (Barcelona).—Personal experiences in the treatment of detachment of the retina and a description of recent operative procedures. (Experiencia personal sobre el tratamiento del desprendimiento de la retina y descripción de sus recientes modalidades operatorias).** *Arch de Oftal. Hisp.-Amer.*, Vol. XXXII, No. 11, p. 614, November, 1932.

(3) In this paper **Arruga** speaks of his own operative results, mainly obtained with the thermo-cautery and by trephining, and also gives a clear and exhaustive account of the principal operations in use for detachment at the present time. Between 1928 and 1932 he saw 216 cases of detachment, of which only thirteen were secondary (intra-ocular tumour, uveitis, metastatic choroiditis and von Hippel's disease). He operated on 164, obtaining cures in 53. He has developed certain points of technique, of which the most noteworthy is the fixation of the eye after the operation by means of a suture through the lower lid and the tendon of the inferior rectus. He attaches the utmost importance to the maintenance of immobility after the operation. He has also an ingenious instrument in the form of a small screw which can be inserted into a trephine hole to block it temporarily in cases where the choroid has been

accidentally perforated and the operation would otherwise have to be abandoned.

A large part of the paper is taken up with a resumé of the work of Guist, Lindner, Weve, Safar, Clausen, Meller and others on the subject.

IDA MANN.

(4) **Arruga, H. (Barcelona).—Experimental adhesive choroiditis. (La coroidite adesiva sperimentale).** *Ann. di Ottal.*, July, 1932.

(4) The mechanism by which Gonin's operation produces a closure of the retinal hole is a matter on which different opinions have been held. **Arruga** has investigated the sequence of events which follow the various procedures belonging to Gonin's and the allied operations. His experiments have been conducted for the most part on rabbits, but some few have been undertaken on eyes which demanded enucleation; this operation being postponed for a few days to see the effects of the cautery puncture.

Arruga finds the sequence of events varies considerably with the method used; after a cautery puncture applied very rapidly the effects are limited; there is swelling of the sclerotic immediately at the wound, but the choroid and retina show little change. The wound is filled by a plug of vitreous which adheres to the episcleral tissues. The retina gradually forms adhesions to the edges of the wound within six or seven days. Two months after the operation the hole is occupied by fibrous tissue which appears to be a continuation of the sclerotic. The adhesion of the choroid and retina to the edges of the hole appears to be very strong. There is apparently no change in the retina beyond the adherent area.

On the other hand, when the action of the cautery is more prolonged, the surrounding tissues are changed by the heat in varying extent according to the duration of the application.

Chemical cauterization, after trephining the sclerotic (Guist's operation), is followed by extensive inflammatory reaction, varying with the concentration of the caustic and its nature. The adhesion following this reaction seems to be more solid than that produced by the actual cautery. The reaction following diathermy is often great and the over-lying retina is often destroyed; in shallow detachments this agent must be used with great caution.

HAROLD GRIMSDALE.

(5) **Lumbroso (Rome).—Wounds of the retina. (Le ferite della retina).** *Rass. Ital. d'Ottal.*, November and December, 1932.

(5) **Lumbroso** has investigated the course of wounds in the retina, using rabbits as the subject of his experiments; he was careful to avoid injury to the subjacent choroid, passing the needle

with which he lacerated the retina through the sclerotic about 5 mm. above the corneal margin, and watching the course of the point through the eye by means of an ophthalmoscope until it reached the retina below the optic disc. The eyes were removed at varying dates after the injury, and the changes carefully noted. Lumbroso finds that there is never recovery of the injured part, but always a more or less extended area round the seat of injury which suffers degeneration.

HAROLD GRIMSDALE.

(6) **Agnello (Syracuse). — Retinitis proliferans following an indirect injury to the eye. (Retinite proliferante per trauma indiretto dell'occhio).** *Lett. Oftal.*, October, 1932.

(6) This case was that of a soldier who was wounded in the leg and fell, striking the left side of his forehead against a rock thus producing a large contused and lacerated wound. He noticed dimness of vision soon after, and in 1922 was discharged from the army; it was then noted that he had retinitis proliferans. This was regarded as not being attributable to the war injury.

Agnello gives his reasons for thinking this judgment incorrect.

HAROLD GRIMSDALE.

(7) **Jaffe, Morris and Schonfeld, William A. (New York).— Lipaemia retinalis due to diabetes mellitus.** *Arch. of Ophthal.*, April, 1933.

(7) Lipaemia retinalis is a rare condition as shown by the observation that lipaemia develops in less than 7 per cent. of diabetics and that in 150 cases of lipaemia there were only two of lipaemia retinalis. Various theories are quoted by **Jaffe** and **Schonfeld** to account for the occurrence of the condition, but none is entirely satisfactory. Bloor believes that it is due to deficiency of a hormone whose function it is to aid in the removal of fat from the blood to the tissues; Allen that in the cachexia accompanying severe diabetes there is interference with the permeability of the cell walls which prevents the passage of fat through them and so leads to its accumulation in the blood; Muskat that it is an attempt to mobilise excessive quantities of fat in order to make up for the defective power of oxidising carbohydrates. Lipaemia retinalis occurs more commonly in young subjects, the average age of those affected being 25, with extremes of 9 and 50 years. The creamy pink colour of the vessels in this condition is not yet certainly explained. It may be due to segregation of the red cells in the middle of the blood stream so that there is a peripheral portion which is opaque, or to accumulation of fat in the adventitia or of

fatty lymph in the peri-vascular lymph spaces. In all probability acidosis is a necessary concomitant to the occurrence of lipaemia retinalis and it was present in the case described by the authors.

F. A. W-N.

(8) **Ask-Upmark, Eric (Lund, Sweden).—On the cortical projection of the temporal half-moon of the visual field.** *Acta Ophthal.*, Vol. X, p. 271, 1932.

(8) **Ask-Upmark** reviews the literature on the cortical representation of the retina and reports a case of circumscribed cortical tuberculoma in the cuneus with loss of the temporal field. From a profusely illustrated and detailed analysis it is concluded that the cortical projection of the nasal retina is in the anterior part of the calcarine region, probably around the confluence of the calcarine and parieto-occipital fissures. Contrary to the general belief, it is held that the upper half of the nasal retina is represented in the superior lip of the calcarine fissure, and the lower half in the inferior lip. Macular projection is nearer to the vertex of the occipital lobe, this being in agreement with the phylogenetic view which regards macular vision as a late acquisition.

ARNOLD SORSBY.

II.—GLAUCOMA

(1) **Werner, S. (Helsingfors).—The effect of subcutaneous injection of Gynergen (Ergotamin) on the tension in glaucoma. (Ueber die Einwirkung subcutaner Gynergen-(Ergotamin)- Injektionen auf den Druck bei Glaukom).**

Clinical investigations on the effect of subconjunctival injection of Gynergen on the tension in glaucoma. (Klinische Untersuchungen ueber die Einwirkung von subconjunctivalen Gynergininjektionen auf den Druck bei Glaukom). *Acta Ophthal.*, Vol. IX, pp. 275 and 286, 1931.

(1) **Werner** reports an investigation in 15 patients (25 glaucomatous eyes) on the effect of subcutaneous injection 0·5 c.c. t. i. d. of ergotamin on ocular tension. Only in five eyes was there any lowering of tension; this treatment did not re-inforce the action of miotics. In 16 cases (18 glaucomatous eyes) the drug was used subconjunctivally. In 14 eyes the tension was lowered, in two it was unaffected and in two raised, the best results with subconjunctival injection were obtained in glaucoma simplex, and though satisfactory they are not so good as those that can be obtained by means of adrenalin and miotics.

ARNOLD SORSBY.

(2) **Fialho, Abreu (Rio de Janiero).—Contributions to the treatment of chronic glaucoma. (Beiträge und Erläuterungen zur chirurgischen Behandlung des chronischen Glaukoms).** *Zeitschr. f. Augenheilk.*, Vol. LXXVI, p. 346, 1932.

(2) **Fialho** discusses the technical difficulties of the trephine operation and proposes two modifications: (1) In cases in which the tension is high and is not controlled by miotics it is advisable to compress the eye to the extent of 150 mm. H_2O for 10 minutes before operation. The lowering of tension thus produced is variable but is always useful. (2) To facilitate the iridectomy the trephine hole should be enlarged in one direction to 3·5 mm. by means of a knife.

ARNOLD SORSBY.

(3) **Zanettin (Padua).—Perception of luminosity in macular and peripheral vision, in chronic primary glaucoma. (Comportamento del senso luminoso centrale e periferico nel glaucoma cronico semplice).** *Ann. di Ottal.*, September and October, 1931.

(3) The little work that has been done on the subject of the behaviour of the luminous sense in glaucoma, says **Zanettin**, has been confined almost exclusively to the study of the central region. In this paper he publishes the results of his observations on a number of glaucomatous eyes.

Lo Cascio has shown that there is a zone round the macula which is less sensitive to light than the macula. From this point, the sensitiveness increases to reach the maximum about 30° or 40° from the centre. Beyond this, it again diminishes.

From his observations, Zanettin finds that in glaucoma the sensitiveness to light is much reduced all over the retina, but the peripheral zone suffers relatively more than the central. He finds that the temporal retina (corresponding to the nasal field) is the first to suffer and then the superior, inferior and nasal areas in that order. The reduction of sensitiveness seems to have a relation to the intra-ocular pressure.

The author regards the alteration in the light sense as a very early symptom of glaucoma.

HAROLD GRIMSDALE.

(4) **Stenico (Florence).—First studies on the presence of histaminoid substances in the aqueous of glaucoma. (Primi tentativi sperimentali diretti alla ricerca di sostanze istamino-simili nell'umore acqueo dei glaucoma osi).** *Boll. d'Ocul.*, December, 1932.

(4) Opinion on the origin of the acute attack in glaucoma has of late inclined to regard it as to some degree comparable to an

acute oedema, and requires for the onset, a predisposition of the vascular system and a toxin which excites the attack. Friedenwald has found in the aqueous of glaucoma a substance which injected subcutaneously produced a wheal similar to urticaria. Histamine has the power of producing similar lesions. **Stenico,** using a coil of intestine of a guinea-pig, finds it possible to detect histamine in solution of 1 in 500,000, by alteration in character of contractions of the muscle. If there is an histaminoid substance present in the glaucoma aqueous, it could be detected in this way.

The author has experimented with the aqueous of a few patients and has found the reaction in one.

HAROLD GRIMSDALE.

(5) **Alajmo (Catania).—Histamine, its action on the normal and on the glaucomatous eye. (L'anzione della istamina sull'occhio normale e sull'occhio glaucomatoso).** *Rass. Ital. d'Ottal.*, January, 1933.

(5) Histamine is an amine which is formed abundantly by putrefactive bacteria; it is very toxic. It brings about a collapse comparable to shock after operation. Its action on the vascular system is complicated; it causes vaso-constriction of the arteries but this is more than counterbalanced by dilatation of the capillaries, and the total result is a great fall in the blood pressure. Its action on the eye has not been carefully investigated and the present paper is based on experiments on animals and to some extent on man.

Alajmo concludes that histamine causes a local vaso-dilatation and chemosis of the conjunctiva; if injected into the anterior chamber in animals it causes an intense irritation with inflammation if the solution is concentrated. The pupil is contracted as a result of the vaso-dilatation of the iris. When injected intravenously, there is mydriasis and a fall in the intra-ocular pressure.

In glaucoma, instillation of a solution into the conjunctival sac is followed by an increase of pressure.

HAROLD GRIMSDALE.

(6) **Biffis (Padua).—The alkalinity of the blood in glaucoma. (L'alcalescenza del sangue nel glaucomatosi).** *Ann. di Ottal.*, February, 1933.

(6) The modern developments of biochemistry have shown the probable importance of the reaction of the tissues whether acid or alkaline. The state of the vitreous gel has been supposed to be closely affected by the reaction of its humours; in this paper **Biffis** summarises recent work on the subject and adds some examinations of his own on the reserve of alkali in the plasma in normal and glaucomatous patients. He finds a slight increase in the alkalinity

of the glaucomatous, though the average is not outside normal limits. Though the increase is small it must be taken into consideration, he thinks, since although it may not suffice to account for the whole syndrome of glaucoma, it may be an adjuvant to other conditions.

HAROLD GRIMSDALE.

(7) **Biffis (Padua).—The relation between calcium and potassium in the blood in glaucoma. (Rapporto tra calcio e potassio nel sangue dei glaucomatosi).** ***Ann. di Ottal.***, April, 1933.

(7) As the ions of hydrogen and hydroxil are opposed in their essential action, so also to some extent are the ions of calcium and potassium. Potassium seems to modify the body metabolism in the direction of alkalinity, while calcium tends to produce acidosis.

In this second paper **Biffis** gives the result of his examination of the blood of a number of glaucomatous patients. He finds a slight deficiency of calcium and a considerable increase of the potassium content; his conclusions are that the deficiency of calcium in the presence of the vitreous determines a lowering of the osmotic pressure and therefore an influx of water; this action is strengthened by the increase in the potassium.

A further result is an increase in alkalinity of the fluids in the tissues; this again favours the onset of glaucoma.

HAROLD GRIMSDALE.

III.—MISCELLANEOUS

(1) **Kreibig, W. (Vienna).—On leukaemic fundus changes. (Ueber leukämische Fundus-veränderungen).** ***Zeitschr. f. Augenheilk.***, Vol. LXXVI, p. 358, 1932.

(1) **Kreibig** reports a case of lymphatic leukaemia in which the symptoms of a cerebral tumour were present, and the fundi showed papilloedema and later on star formation at the macula, together with multiple small white retinal exudates peripherally. Post-mortem a large subdural leukaemic infiltrate was found in the middle cranial fossa, but no leukaemic infiltrates could be found in the retinae, papilloedema and haemorrhages only being seen microscopically. The author holds that the fundus changes are to be explained by the increased intracranial pressure acting on a retina with vessels prone to bleed.

ARNOLD SORSBY.

(2) **Lugli. (Bologna).—Ocular lesions in experimental avitaminosis. (Lesioni oculari da avitaminosi A sperimentale).** *Rass. Ital. d'Ottal.*, January, 1933.

(2) The relation between xerophthalmia and the deficiency of vitamin A has been remarked for a considerable time; it is not clear, however, whether the lesions found are entirely due to the food deficiency or whether they are due to the coincidental attacks of pathogenic micro-organisms.

To clear up this and other points, **Lugli** adopted the plan of performing tarsorrhaphy on one side of the animals under investigation, before the feeding experiments were begun. In this way one eye was guarded against accidents from external bacteria. He found that when the tarsorrhaphy was complete, the protected eye showed changes in the epithelium but much less than the unprotected eye which in all cases suffered ulceration and perforation. He concludes that the more serious effects are due to bacterial infection, which is made more virulent owing to the changes in the epithelium.

HAROLD GRIMSDALE.

(3) **Gertson and co-workers. (Grand Forks, N.D.).—Wohlfartia myiasis in North Dakota.** *Jl. Amer. Med. Assoc.*, February 18, 1933.

(3) Two cases of Wohlfartia infestation are reported, one of which is of the orbit. **Gertson** state that they have failed to find in the literature any report of orbital infection with the larvae of this fly Wohlfartia vigil (Walker). Had access to the Bulletin of the Ophthalmological Society of Egypt for 1917 been available they would have found a report of cases of "Fly-blown Orbit" by Barsoum, due to Wohlfartia Magnifica (Schinner). This fly is viviparous. It can settle on the conjunctiva for a fraction of a second, deposit a living larva, and fly away. The larva or larvae begin at once to eat a way into the orbit, and the condition unless it is recognised early, may cause terrible damage. It is not uncommon in Egypt.

A. F. MACCALLAN.

(4) **Mayer, L. L. (Chicago). — Congenital reading disability.** *Jl. Amer. Med. Assoc.*, April 15, 1933.

(4) This interesting article does not lend itself to full abstraction but some points may be alluded to. It is accompanied by a good bibliography of the subject with due reference to Morgan and to Hinshelwood. The first mention of ocular dominance found in the literature was made by Porta in 1593. This is an important feature in acquired, congenital and partial word blindness. Porta

noted that right-handed individuals preferred to use the right eye to the exclusion of the left eye when aiming. Among the methods of testing ocular dominance is to look at the middle letter of the 6/24 line of the Snellen test-type, to point your finger at it and then close the left eye. If you are right-eyed you are covering the letter accurately, if you are left-eyed you are not. It has recently been shown in the lay press that stammering is especially common among left-handed children who have been taught to use their right hands for writing. Loss of nervous balance may be produced in this way. B. S. Parson, a great authority on this subject, in studying a large group of school children reports that out of 877, 29.3 per cent. were left-eyed; of 608 who were right-eyed, 99.5 per cent. were right-handed; of 257 who were left-eyed only 12.4 per cent. were left-handed. Orton states that the master eye is a safer guide to native dominance than the master hand. It is of interest to note that in his Bradshaw Lecture in 1932 the late revered Herbert Fisher stated his opinion that the idea of a master eye was a fallacy. Those who are interested in this subject should not neglect Macdonald Critchley's paper before the Section of Neurology of the Royal Society of Medicine on Dec. 9th, 1926.

A. F. MACCALLAN.

(5) **Llorca, J. P. (Cadiz).—Contribution to the origin and nature of the vitreous body. (Contribucion al origen y naturaleza del cuerpo vitreo).** *Arch. de Oftal. Hisp.-Amer.*, Vol. XXXII, No. 10, p. 540, October, 1932.

(5) In a painstaking paper **Llorca** re-opens the perennial controversy concerning the origin of the vitreous. He considers that he can bring forward further arguments in favour of the participation of the vascular mesoderm in the formation of the vitreous, not only in mammals but also in birds although this has recently been denied by Redslob. The paper is divided into four sections and a bibliography. The first section deals with previous work and affords a résumé of present views on the subject. The second enumerates the material and methods employed. The third, illustrated by numerous micro-photographs, is a record of the author's personal observations, while the fourth deals with his interpretations and conclusions.

The material employed consisted of chick embryos in series up to the sixth day, as well as of rabbit, guinea pig and calf embryos. Various methods of fixation were employed to obviate artefacts due to any one solution. Simple, differential and impregnation methods of staining were used.

The author concludes in the first place that the vitreous is not a true tissue, the cells within it being merely included, not an essential

part of it. Secondly, he sees no reason to suppose it a secretion of the retinal or lentine epithelium since, although vitreous fibrils may appear strongly attached to either of these layers, they are attached more strongly still to the walls of the intra-ocular blood vessel (hyaloid or artery of the pecten as the case may be). He therefore considers the vitreous to be a transudate, more or less altered by unknown circumstances. It appears first in the neighbourhood of the vessels even in birds, in which the intra-ocular vessel remains small and confined to the lower part of the eye and its fibrils always remain attached to vascular remnants or to the pecten, itself a vascular structure.

IDA MANN.

(6) **Krug, Ernest F. and Rohdenburg, G. L. (New York).—Foreign substances injected into the vitreous of the rabbit.** *Arch. of Ophthal.*, July, 1932.

(6) **Krug** and **Rohdenburg** begin their paper with a survey of our present knowledge of the pathway from one eye to its fellow. In 1924 Mariani inoculated three rabbits with the scrapings from herpetic keratitis with resulting inflammation in the fellow eye in 16-18 days. In 1927 von Szily demonstrated histologically that the infiltration extended from eye to eye along the optic tract. Deutschmann in 1903 obtained the eyes, optic tracts and chiasma from a patient who suffered from sympathetic ophthalmitis and died from gastric carcinoma. The meninges, brain and ciliary nerves were normal while both optic tracts and the chiasma showed round-celled infiltration. The authors of this paper injected various substances into the vitreous of a series of rabbits' eyes with the following results:—(i) Various oils pigmented by Scharlach R. These showed that the pathway of the intra-ocular fluids was from the vitreous to the retina, between the cells of the retina to the choroid, through the lymph-clefts of the nerve, particularly those about its sheath and about the central blood vessels, to the chiasma and so down the opposite nerve to the fellow eye. (ii) Indian ink particles were taken up by wandering cells some of which after seven days had passed up the optic nerve, through the chiasma and down to the nerve head of the opposite eye. (iii) Kieselguhr appeared to travel even more quickly and wandering cells carrying particles of this substance were found in the nerve head of one eye within five days of injection into the vitreous of the fellow eye. Living streptococci (viridans) and living tubercle bacilli injected in the vitreous, produced marked inflammatory changes with resulting plastic exudate covering the nerve head. This exudate acted as a mechanical barrier to the passage of the organisms down the lymph spaces of the optic nerve.

F. A. W-N.

(7) **Weekers, L. (Liège).—Ophthalmotonic reactions following experimental puncture of the ciliary body. (Réactions ophtalmotoniques expérimentales par piqure du corps ciliare).** *Arch. d'Ophtal.*, January, 1932.

(7) Lesions which involve the ciliary body, whether inflammatory or traumatic, lead frequently to notable modifications of intra-ocular pressure. The derangement consists sometimes of augmentation, sometimes of diminution of tension. Neither the nature nor the mechanism of the change is clearly understood.

In a paper published some years ago, Pesme and Duthil recorded the results of experiment on a rabbit: with a very fine needle they punctured the eyeball about 1 mm. from the limbus over the ciliary body. The needle was withdrawn sharply and escape of aqueous avoided. This experimental trauma induced an immediate fall in intra-ocular pressure; in 8 minutes it had dropped from 25 mm. to 10 mm. of Hg, and this hypotonus persisted for 36 hours. The authors suggested that the rapidity of the phenomena could be explained only by nerve influence; that the puncture of the ciliary body provoked an active and prolonged uveal vaso-constriction leading to diminished blood-flow into the eyeball, and consequent hypotonus.

Weekers has made similar but more numerous experiments and has been led to conclusions concerning the cause of the hypotonus which differ widely from those just quoted. He observed a similar rapid lowering of intra-ocular pressure after puncture of the ciliary body, lasting for 48 hours. By the use of subcutaneous injections of fluorescein he satisfied himself not only that vaso-constriction is not induced but that vaso-dilatation occurs. The colouring matter passed into the punctured eyeball much more freely than into its untouched fellow. Careful examination, under magnification, of the site of puncture, even when made by oblique insertion of the finest needle, always revealed evidence of leakage from the perforation.

In his experiments Weekers has noted varying results of this form of trauma: thus he has found an absence of immediate hypotonus but after a few hours a noticeable and prolonged lowering of pressure: again he has obtained a brief elevation of pressure followed by a hypotonic phase of more than 24 hours duration. These variations of pressure, in his opinion are characteristic of the ophthalmotonic reactions following puncture of the ciliary body.

It is possible to induce derangement of ocular tonus in very varied ways: by massage, by compression or contusion of the globe, by cauterisation of the sclera, by puncture of the iris, etc.

In an earlier paper Weekers published a critical study of this subject and attempted to elucidate the general laws which control experimental ophthalmotonic reactions, both direct and consensual. His conclusions are, briefly: all the procedures adopted consist

essentially in traumatism of the eyeball. When this is severe it induces sudden and intense vaso-dilatation, a veritable turgescence of the uvea; the wall of the globe being rigid, a rapid augmentation of its contents is followed by rise of pressure. But this hypertonus is of short duration and is succeeded by lowered pressure lasting as long as the former hypertonus. If the trauma is less severe, and the uveal congestion less intense, the initial phase of hypertonus is slight and short; it may pass unperceived and only the phase of hypotonus be manifest.

The consensual modifications of intra-ocular tension in the non-traumatised eye, are due to reflex vaso-dilatation, but though similar they are much less in degree than those of the wounded eyeball; they may fail to be apparent except when the direct reactions to the injury have been severe.

Experimental ophthalmotonic reactions such as are here described, may be observed clinically in certain contusions of the eyeball.

J. B. LAWFORD.

(8) **Giuffrida (Novara).—The prevention of industrial blindness. (Sulla prevenzione degli infortuni agli occhi nell'industria).** *Ann. di Ottal.*, July, 1932.

(8) The loss to industry from accidents to the eyes of workmen, is very great and could be prevented in large measure by the use of suitable protection. Unfortunately, from one cause or another many workmen are unwilling to use the protection which is provided for them and has been proved to be effectual.

The reasons for this are not far to seek; the goggles are often not comfortably adjusted to the individual, they necessarily reduce the visual field and to some extent the visual acuity since the surface is often clouded by moisture and also becomes, in course of time, scratched by the flying splinters which are constantly striking the surface.

Giuffrida shows that the loss of working time due to accidents to the eyes in a large metal works in Piedmont, was one-tenth of the time lost through all accidents.

Even when the injury is superficial, immediate skilled care is very necessary; removal of foreign bodies by unskilled hands is not infrequently followed by infection of the cornea and dangerous ulceration. Since the workmen have been ordered to consult the medical staff after all injuries to the eyes, however slight, there has been a considerable reduction in the time lost from these accidents.

HAROLD GRIMSDALE.

BOOK NOTICES

A Short History of Ophthalmology. By ARNOLD SORSBY, M.D., F.R.C.S. Pp. 94, 6 illustrations, 1 coloured print. London: John Bale and Sons. 1933. Price, 3s. 6d.

This volume forms one of a series of "Short Histories," and does not belie its name, since the author has succeeded in compressing the history of ophthalmology within a compass of 92 pages—an achievement on which he is to be congratulated. Despite the shortness of the book, it is not in any way a mere summary, but is eminently readable and contains much that will interest not only the medical but also the lay reader. The latter would no doubt be amused to know that in the Code of Hammurabi, an unsuccessful operation on a freeman which caused loss of the eye entailed for the surgeon the loss of his hands. The author in his preface, states that he has attempted to "record the culmination of apparently unconnected activities into what constitutes modern ophthalmology." With this object in view we find after an introductory section that the book is divided into chapters dealing with the history of Ophthalmic Anatomy, Pathology, Cataract, Glaucoma, and the other branches of ophthalmology. Each of these is well written and contains facts which ought to be known more widely. How many ophthalmologists for example could say off hand when spectacles were first employed? or that the use of the trial case was introduced less than 100 years ago. History does not of course appeal to everyone, but even the least curious of men must want to know something about the origins of the art which he practises, and it is for such as these that "A Short History of Ophthalmology" has been published. For those who wish to pursue the subject further, there is a bibliography at the end of the book giving the titles of larger and more comprehensive works. Among these is the well-known work by R. R. James recently published under the auspices of this journal, the author of which contributes an admirable foreword to the volume under review.

Transactions of the Ophthalmological Society of the United Kingdom. Vol. LIII. London: J. and A. Churchill. 1933.

The volume of Transactions contains the papers read before the Annual Congress, 1933, and those contributed to the affiliated Societies. It is full of interest and compares favourably with any of its forerunners. The Society suffered heavy losses through the death of Mr. Priestley Smith, Mr. Treacher Collins, Mr. Herbert Fisher and others. The financial position is sound and the membership is satisfactory. The Secretaries deserve credit for getting the volume published in such good time.

Stereoskopische Bilder für schielende Kinder. By Professor C. H. SATTLER (Königsberg). Fifty-four illustrations. Second edition. Stuttgart: Ferdinand Enke. 1933. Price: R.M. 6.10.

Bilder für Stereoskopische Uebungen zum Gebrauch für Schielende. By C. DAHLFELD. Part I: 32 illustrations. Thirteenth edition. Part II: 30 illustrations. Third edition. Stuttgart: Ferdinand Enke. 1933. Price: R.M. 5.85 each part.

Prof. Sattler's series of stereoscope pictures on cardboard are designed to maintain the interest of young children; the designs are therefore of simple objects. Dr. Dahlfeld's series show a greater variety and also considerable ingenuity in their construction. As far as both these series go, they are good examples of this sort of illustration, but neither series involves any new principle. These pictures do not lend themselves for use with the more elaborate apparatus now employed in this country.

OBITUARY

ANDREW WILSON

DR. ANDREW WILSON, Hon. Consulting Ophthalmic Surgeon and formerly Surgeon to the Glasgow Eye Infirmary, died, aged upwards of 70 years, on December 29, 1933, at his residence in Glasgow. He was a "son of the manse," his father having been parish minister of Drymen in Dumbartonshire, with a family of eight sons.

After graduating M.B., C.M.(Glasgow) with high commendation in 1885 (M.D., 1902), Andrew Wilson filled various posts as House Surgeon and House Physician, including the House Surgeoncy at the Glasgow Eye Infirmary. He was appointed Assistant Surgeon to the last-named Institution in 1891, and Surgeon in 1897. He held this post until 1919 when he retired from it after completing military service in Wales. For many years Wilson had acted for the Scottish Mineowners Defence Association in connection with compensation claims.

He was always a reserved and rather silent man who avoided publicity. Only seldom was he seen at professional society meetings, and, strangely enough, he never joined the Ophthalmological Society of the United Kingdom. This preference for freedom from publicity meant that little appreciation of his qualities by his contemporaries outside of the Glasgow district was possible. To his colleagues and his professional friends in Glasgow his personal

qualities and his professional reputation were well known. His main training was obtained under the late Dr. Thomas Reid, of Glasgow, in his day one of the foremost ophthalmic surgeons in Britain, and from early in his career he was recognized as a first class operator. The fact that Wilson published very little is consistent with his retiring nature, yet, so long ago as 1903 he wrote on the treatment of cataract by simple extraction. (*Scott. Med. and Surg. Jl.*)

The writer of this note was Wilson's Clinical Assistant—and afterwards his Assistant Surgeon—for some seven years and he can speak to his operative ability and skill and also to his helpfulness to others. He was a tireless and persevering note taker of everything he observed, not only when dealing with in-patients but even when harassed by excessive numbers in the out-patient department, and the notes were frequently accompanied by neat and informative sketches. At the operation table he was a model of almost silent calmness and dexterity. His fingers were short and stubby and free from any vestige of tremor or hesitancy, but what these somewhat unlikely looking fingers could do, associated as they were with their owner's slightly myopic refraction, was a revelation. To Andrew Wilson's step-children (his wife died some time ago) and to his surviving brothers, colleagues and many friends will wish to extend their kindly sympathy.

E. T.

NOTES

Honour

AMONG the New Year's honours we are pleased to see the name of Sir William Lister who receives the K.C.V.O.

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Ophthalmological Society of the United Kingdom, Annual Congress

THE Annual Congress of the Ophthalmological Society will be held in London on April 12, 13 and 14, 1934.

The subject for discussion will be: "The Surgical Treatment of the More Unusual Forms of Squint and Heterophoria, with Especial Reference to End Results." Openers will be Dr. F. Bernard Chevasse and Mr. W. H. McMullen. Will members who wish to take part in this discussion kindly notify Miss Ida Mann before February 28?

Members wishing to read papers will kindly send the titles as soon as possible to Miss Ida Mann. Abstracts of the papers should

be sent not later than April 1, and will be circulated at the meeting.

A Scientific Museum will be held in connection with the Congress, and members exhibiting will be invited to give five-minute demonstrations on their exhibits on the afternoon of Friday, April 13. Will those wishing to take part kindly notify Miss Ida Mann as soon as possible?

The Annual Dinner of the Society will be held on Thursday, April 12.

FUTURE ARRANGEMENTS

1934

February 2.—Midland Ophthalmological Society, at Leicester.
February 9.—Section of Ophthalmology, Royal Society of Medicine.
February 16.—North of England Ophthalmological Society, at Newcastle-on-Tyne.
March 9.—Section of Ophthalmology, Royal Society of Medicine. (Clinical Meeting.)
March 16.—North of England Ophthalmological Society, at Liverpool.
April 13.—North of England Ophthalmological Society, at Sheffield.
May 11.—Joint Meeting of the Midland and North of England Ophthalmological Societies, at Nottingham.
June 5.—Midland Ophthalmological Society, at Northampton.
June 8.—Section of Ophthalmology, Royal Society of Medicine. (Annual.)
July 4-7.—Oxford Ophthalmological Congress, at Oxford.
October 2.—Midland Ophthalmological Society, at Birmingham. (Annual Meeting)

CONTEMPORARY OPHTHALMIC LITERATURE

American Journal of Ophthalmology. *December, 1933.*

KIRBY. The mechanism of senile cataract.
GIFFORD and PUNTENNY. The biochemistry of the lens. II. A study of cataracta brunescens.
LEBENSOHN. The biochemistry of the lens. III. Water equilibrium in the normal and cataractous lens.
EDGERTON. Heterochromia and cataract,
SHAPIRA. Seatosis bulbi with special reference to the cornea.
BERKE. Changes in refraction with hyperglykemia.
PISCHEL. Detachment of the retina—its present operative treatment.

Archives of Ophthalmology. *December, 1933.*

KNAPP. Operative treatment of retinal detachment with electrocoagulation.
FRALICK. The Khan reaction in the aqueous humour; its relation to syphilis of the eye.
JAFFE. Retinal detachment in toxemias of pregnancy.
ABRAHAM. Mydriatic glaucoma: a statistical study.
BOCHNER. Use of nupercaine in ophthalmology.
DUGGAN. Visual results in cases of intra-ocular foreign bodies: a study of two hundred and seventy cases.
KRAUSE. Chemistry of the lens. V Relation of the anatomic distribution of the lenticular proteins to their chemical composition.
CRAWFORD. Hole in the macula: report of a case in a patient under observation.
GIFFORD. Rodent or Mooren's ulcer of the cornea. Report of three cases with healing.
GOLDBACH. Leukemic retinitis.

Annales d'Oculistique. *December, 1933.*

LAGRANGE and DELTHIL. Allergic reactions of the ocular conjunctiva.
VELIÈRE-VIALEIX. Chronic conjunctivitis caused by unrecognized concretions of the lower lacrymal canaliculus.
REDSLOB. Contribution to the study of the pathological anatomy of retinitis pigmentosa.
SHOJI. Cinematograph of ophthalmic operations.

Archives d'Ophtalmologie. *December, 1933.*

WEEKERS and DAUTREBANDE. Study of the vasomotor reactions of the retina to experimental hypertension.
JEANDELIZE and BAUDOT. Our actual results of the treatment of retinal detachment by diathermy.
DEJEAN. Lymphoid hypertrophy of the conjunctiva with opaline protuberances.
FRANÇOIS. Inflammatory ectropion and its treatment by total tarso-conjunctival excision.
ADAMIANTIADIS. Latent syphilis and post-operative ocular complications.
ALEXIADÈS. Late post-operative infection seven months after an Elliot's trephine on a patient suffering from bilateral chronic glaucoma.

Archiv für Ophthalmologie. *November, 1933.*

URBANEK. Fat-embolism of the eyes.
TABORISKY. Histology of early trachoma and follicular conjunctivitis.
PAUL. Contribution to localization ophthalmoscopy.

Annali di Ottalmologia e Clinica Oculistica. *October, 1933.*

CASCIO and BERTUSSO. Spectrographical research on the lens.
NICOLATO. Retinal and cerebral angioma.
WEINSTEIN. Relation between ophthalmology and neurology.
DE BLASKOVICS. Artificial ptosis for the protection of the cornea.
PETRONI. On the valuation of the intensity of monochromatic light for the determination of the threshold of retinal excitability.

Archivio di Ottalmologia. *September-October, 1933.*

CORDERO. A case of membranous ankyloblepharon at birth (clinical and anatomico-pathological study) with research on the formation of the lid margin.
SPINELLI. Anatomico-pathological contribution to experimental retinal detachment.

Lettura Oftalmologica. *October, 1933.*

D'OSVALDO. The clinical importance of Bailliart's sign as an indication of cephalic arterial hypertension.
VELE. The heterologous polymorpho-leucocyte in an experimental septic wound of the cornea.
SANGUINETTI. Palpebral epitheliomata.

November, 1933.

D'OSVALDO. Clinical research on the behaviour of the light and chromatic senses, central and peripheral, in nephritis without ophthalmoscopic neuro-retinal alterations and with normal central visual acuity.

Rassegna Italiana d'Ottalmologia. *September-October, 1933.*

ALAJMO. Xeroderma pigmentosum with ocular lesions.
SUSUMANO. Trachoma and the constitution treated by autogenous vaccine.
KOCH. Corneal lesions from obstetrical intervention (observations in adults).
SALA. Experimental research on the relation between the cervical sympathetic and vaso-motor changes in the dog.
LUMBROSO. Some particular histo-pathological findings from the examination of some cases of cicatricial trachoma.
BIONDO. The action of naphthalene vapour on the eyes.
GALLENGA. Clinico-experimental study on a persistent bradycardia of orbital origin.

Archivos de Oftalmologia Hispano-Americanos. *December, 1933.*

MOREU. The treatment of tuberculous iridocyclitis by autogenous blood injection into the anterior chamber.
SELFA. Copper citrate in the treatment of trachoma.

Revista Oto-Neuro-Oftalmologica. *October, 1933.*

PAVIA and DUSSELDORP. Tear of the retina, without detachment, co-existent with senile degeneration, spontaneous cure and new tear.
PAVIA. Intrinsic shadows of the fundus, parieto-vascular proliferations. Cinematograph and stereocinematography of the retina.
——— Schools for amblyopic children. The importance of the social condition for the prevention of the cause of blindness.

Revista Oto-Neuro-Oftalmologica y de Cirugia Neurologia. *December, 1933.*

HALBERTSMA. Case of carcinoma of the lacrymal sac.
PAVIA. Notable improvement in a case of papilloedema treated by deep radiotherapy.

Archivos de Oftalmologia de Buenos Aires. *August, 1933.*

BALADO and FRANKS. Studies on the optic tracts. VII. The paths of the optic radiations in man.
WESKAMP. Neurosis of the central vessels of the optic nerve.
COURTIS. Pathological anatomy of the cornea in glaucoma.

September-October, 1933.

GUIST. The operation for retinal detachment with caustic potash and its further development.
LUQUE. An atypical case of nasal nerve syndrome.
GALLINO. Schools for amblyopes.
MANES and MOULIÉ. The results of the first group of cases of retinal detachment treated in this country by means of surgical diathermy.